February 9, 2023

Mr. Rob Kondreck
On-Scene Coordinator
U.S. Environmental Protection Agency, Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604

Subject: Air Monitoring Plan and Sampling and Analysis Plan – Revision 1
Nelson Knitting Site – RV
Rockford, Winnebago County, Illinois
EPA Contract Number: 68-HE-0519-D0005
Task Order – Task Order Line Item Number (TO-TOLIN): F0032-0001DL101
Document Tracking Number: 1586a

Dear Mr. Kondreck:

The Tetra Tech, Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START) hereby submits this revised air monitoring plan (AMP) and sampling and analysis plan (SAP) for the Nelson Knitting Site - RV (the Site) in Rockford, Winnebago County, Illinois. The AMP/SAP summarizes in-field air monitoring and sampling and off-site analyses to be completed in association with removal activities at the Site.

Please call me at (312) 201-7763 or email me at Alexis.Enright@tetratech.com if you have any questions or comments regarding this submittal.

Respectfully,

Alexis Enright
Project Manager

Enclosure

cc: TO-TOLIN file
Karl Schultz, Tetra Tech Program Manager

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AIR MONITORING PLAN AND SAMPLING AND ANALYSIS PLAN

NELSON KNITTING SITE – RV

ROCKFORD, WINNEBAGO COUNTY, ILLINOIS

Revision 1

February 9, 2023

Prepared for:

U.S. Environmental Protection Agency, Region 5
77 West Jackson Boulevard
Chicago, IL 60604

Submitted by:

Tetra Tech, Inc. Superfund Technical Assessment and Response Team
1 South Wacker Drive, Suite 3700
Chicago, IL 60606

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APPENDICES

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1. INTRODUCTION

This air monitoring plan (AMP) and sampling and analysis plan (SAP) identifies data acquisition and associated quality assurance/quality control (QA/QC) measures specific to the Nelson Knitting Removal Site (the Site) in Rockford, Winnebago County, Illinois (Appendix A, Figure 1 and Figure 2). The Site-specific sampling, analytical, and QA/QC procedures herein will accommodate the project scope of work and requirements specified by the U.S. Environmental Protection Agency (EPA).

Data acquisition activities are discussed throughout this AMP/SAP. The QA/QC procedures described herein are limited to relevant, site-specific information not already included in the Tetra Tech, Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START) quality assurance project plan (QAPP), which functions as the EPA-approved branch-level QAPP (Tetra Tech 2022).

2. SCOPE OF WORK

Under Contract Number 68-HE-0519-D005, Task Order-Task Order Line Item Number (TO-TOLIN) F0032-0001DL101, EPA tasked START with air monitoring and air sampling activities in support of the removal of asbestos-containing material (ACM) and waste material at the Site in Rockford, Winnebago County, Illinois (Appendix A, Figure 1). The removal action was initiated to mitigate the threat posed by the presence of asbestos and uncontrolled hazardous substances at the Site. The goal of START's work is to perform air monitoring and air sampling to evaluate the need for enhanced engineering controls and the possibility of offsite migration of airborne contaminants.

This AMP/SAP describes field screening, sampling, analytical, and QA/QC requirements for activities at the Site. Figures and tables for this AMP/SAP are in Appendix A and Appendix B, respectively. Tetra Tech standard operating procedures (SOP)—including site-specific SOPs to be applied during removal activities—are provided in Appendix C. Other environmental SOPs to be referenced during removal activities are included in Attachment 1.

3. PROJECT TEAM

Personnel listed in Table 1 will be involved in planning or technical activities pertaining to the Site. The EPA on-scene coordinator (OSC) and each field team member will receive a copy of this AMP/SAP, and a copy will be retained in the site file.

Table 1 — Project Team

Personnel	Title	Organization	Phone	Email
Rob Kondreck	OSC	EPA	312.353.6684	Kondreck.Robert@epa.gov
Alexis Enright	Project Manager	START	312.201.7763	Alexis.Enright@tetratech.com
Kris Schnoes	QA Manager	START	312.201.7480	Kris.Schnoes@tetratech.com
Daniel Higley	Field Staff	START	312.201.7415	Daniel.Higley@tetratech.com
Christopher Long	Response Manager	EQM	989.233.9095	Cslong@eqm.com

Notes:
EPA: U.S. Environmental Protection Agency
OSC: on-scene coordinator
QA: quality assurance
START: Superfund Technical Assessment and Response Team

4. SITE LOCATION AND DESCRIPTION

The Site is located at 909 South Main Street in Rockford, Winnebago County, Illinois (Appendix A, Figure 1). Geographic coordinates at the center of the Site are latitude 42.263771 degrees north and longitude 89.101911 degrees west.

The Site is in a mixed-use area of Rockford, Illinois, and is bounded to the north by a wooded lot and the Kent Creek beyond; to the east by commercial properties and South Main Street; to the south by Kent Street and a vacant lot; and to the west by the Tinker Swiss Cottage Museum Campus (Appendix A, Figure 2). The Site contains a three-story former manufacturing building that was owned by the Nelson Knitting Company and operated as a sock knitting mill until approximately 1990. Since 1990, the building has been vacant.

The City of Rockford contracted Fehr-Graham & Associates (FGA) to conduct a Phase I Environmental Site Assessment (ESA) in 2008. The Phase I ESA identified suspected ACM on piping, steam pipe elbows, and boilers and suspected lead-based paint (LBP), containers of chemicals, mercury-containing fluorescent lamps, and suspected polychlorinated biphenyl (PCB)-containing fluorescent lamp ballasts and electrical capacitors. The FGA Phase I ESA additionally included Sanborn maps from 1950 and 1951 that indicated the building was constructed of fireproof materials and was expected to contain sheetrock and poured asbestos (FGA 2008).

The City of Rockford contracted FGA to conduct a Phase II ESA in 2009. The Phase II ESA identified subsurface contamination with PCBs and polynuclear aromatic hydrocarbons (PNA) near three historical electrical transformers on the southeast exterior wall of the facility. PNA compounds at only one sample location were found to be above the Illinois Environmental Protection Agency (IEPA) regulations, but the concentrations were below the EPA Removal Management Levels (RML) (FGA 2009).

On June 25, 2020, the City of Rockford determined that the entrance to the Site was compromised. An inspection of the building found that the boilers and other steel products had been removed. Suspected ACM from the boilers and pipes were found discarded in piles on the floor, as well as in garbage bags and fiber drums. The roof was also observed failing in multiple locations. On June 26, 2020, the City of Rockford condemned and secured the property (City of Rockford 2020) and contacted the EPA Emergency Response Branch to request assistance with the Site on June 29, 2020.

On September 18, 2020, EPA issued TOLIN 0001BI104 to Tetra Tech to perform a removal site evaluation (RSE) at the Site to (1) determine the risks posed to human health and the environment through potential exposure to ACM and hazardous waste and (2) determine if a removal action by EPA was warranted. On October 8, 2020, EPA and START collected one sample containing ash, one liquid sample from the sump, two paint samples, seven bulk asbestos samples, one ballast sample, and eleven air samples to determine whether removal actions were necessary.

Results from this investigation indicated that three of the seven bulk asbestos samples were friable and contained either chrysotile or amosite asbestos. The asbestos content in these samples ranged from 50 percent to 70 percent. Air sample results indicated that fibers matching asbestos characteristics were detected in the boiler room and east access point air samples. Action levels were also exceeded for PCBs in the light ballast sample and lead in the ash sample, sump sample, and one paint sample (Tetra Tech 2020b).

Based on the observations during the site assessment and the analytical results of the samples containing hazardous constituents above applicable action levels, START recommended the removal of the hazardous materials before the building could be considered safe to enter without personal protective equipment (PPE). This recommendation was based on evidence of trespassing into the building, which contained dry, friable, and severely compromised ACM. ACM in a compromised state does not need significant disturbance to result in concentrations of asbestos fibers in the air throughout the building to be above the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 0.1 fibers per cubic centimeters of air (f/cc) (Tetra Tech 2020b).

EPA and START concluded Site conditions and the presence of friable ACM, as well as hazardous materials, including PCB lighting ballasts, lead-acid batteries, miscellaneous chemicals, mercury switches, and fluorescent lamps, at the Site pose a potential threat to both human health and the environment and meet the criteria of a removal action, as defined under Title 40 *Code of Federal Regulations* (40 CFR), Section 300.415(b)(2) (EPA 2022).

Monitoring and sampling described in this AMP/SAP will support planned removal activities at the Site.

5. PROPOSED SCHEDULE

The initiation of removal activities is anticipated during the week of January 30, 2023, with the expectation of completion within six weeks. Tentative project milestones and deliverables are shown in Table 2.

Table 2 — Proposed Schedule

Task	Completion Timeframe
Air Monitoring and Sampling and Analysis Plan (Revision 0)	January 25, 2023
Site Mobilization	January 30, 2023
Field Work	Approximately 6 weeks after mobilization
Review and Evaluate Air Data	
Laboratory Analytical Reports	2 weeks following sample submittal
Data Validation Report(s)	10 days following receipt of the final laboratory analytical report
Letter Report	30 days following receipt of the final data validation report(s)

6. REMOVAL APPROACH

Tetra Tech reviewed results of the FGA Phase I ESA (FGA 2008), Phase I ESA Update and Phase II ESA (FGA 2009), and the START RSE (Tetra Tech 2020b) to determine the nature and extent of contamination at the Site. This AMP/SAP focuses solely on the removal of ACM on the Site. Other contaminants identified are not an airborne exposure concern.

EPA proposed removal actions include:

- Delineate the extent of all solid waste materials that may be found on Site and delineate and determine the extent of asbestos found on Site;
- Characterize and segregate, when possible, ACM waste from waste not containing ACM;
- Load, transport, and dispose of ACM, identified hazardous substances, pollutants, ACM-impacted wastes, or contaminants at an EPA-approved disposal facility in accordance with the EPA Off-site Rule (40 CFR § 300.440); and
- Take other response actions to address any release or threatened release of a hazardous substance, pollutant, or contaminant that the EPA OSC determines may pose an imminent and substantial endangerment to the public health or the environment.

7. FIELD ACTIVITIES

START will provide oversight and acquire data to support the removal of ACM and asbestos-contaminated material from the Site. Digital data acquisition via tablet computers will involve air monitoring and air sampling during removal activities. START will document sampling activities using electronic forms when available and will store this information in the Scribe database; all other documentation will follow procedures outlined in Tetra Tech SOP 024-4, “Recording Notes in Field Logbooks” (Appendix C).

7.1. AIR MONITORING AND SAMPLING

START will conduct air sampling for asbestos and air monitoring for particulate matter prior to removal to obtain background and during removal to document and assess the possibility of off-site migration of airborne contaminants. START will deploy two air monitoring stations at the perimeter near entrances to the facility at the personnel entrance and at the dock or opening where a roll-off box will be staged. A third station will be deployed if an additional opening to the building is required for removal activities (Appendix A, Figure 3).

START will deploy two types of equipment at each air monitoring station: (1) a Gilian AirCon2 air sampling pump to collect samples for laboratory analysis for fiber concentrations and potentially asbestos fiber concentrations and (2) a TSI DustTrak DRX (DustTrak) monitor to provide real-time particulate concentrations.

Periodic personal sampling will be conducted within the workers’ personal breathing zone (PBZ) while working with ACM or asbestos-contaminated material to ensure that asbestos levels remain below the 8-hour time-weighted average (TWA) PEL and 30-minute excursion limit, as per 29 CFR §1926.1101(f)(2).

START may also conduct personal activity-based air sampling during the removal of ACM and asbestos-contaminated material at the Site. The objective of activity-based air sampling is to evaluate risks posed to trespassers of the Site. The activities and locations will be determined by the OSC. Sampling will be conducted according to the EPA Environmental Response Team’s (ERT) SOP 2084, “Activity-Based Sampling for Asbestos” which is provided in Attachment 1.

7.1.1. Gilian AirCon2 Air Sampling Pump

START will deploy a Gilian AirCon2 high-volume air sampling pump equipped with a 25-millimeter (mm), 0.8-micrometer (µm) mixed cellulose ester (MCE) filter cassettes at each air monitoring station to collect air samples to be analyzed for asbestos. The pumps will be calibrated by use of a BIOS DryCal air flow calibrator to achieve a flow rate resulting in the collection of at least 4,000 liters of air during a 10-hour work shift. Calibration will occur before each sampling event in accordance with Tetra Tech SOP No. 064-1, "Calibration of Air Sampling Pump" (Appendix C). The flow rate will be checked again for any change at the end of each sampling period. Sample collection information will be recorded on digital data forms. Samples will be collected approximately 4 to 5 feet above the ground to represent exposure in the breathing zone. The filter cassettes will be placed in a downward approximately 45-degree position with the inlet caps of the filter cassettes removed (open-faced) during sampling.

Air sampling will be conducted each day that removal activities are performed. Samples will be submitted to the START-procured laboratory for asbestos analysis in accordance with the guidelines established in 29 CFR 1926.1101 using National Institute for Occupational Safety and Health (NIOSH) Method 7400, "Asbestos and Other Fibers by PCM." If air sample analyses indicate that asbestos fibers have migrated off-site, START will immediately notify the EPA OSC so additional engineering and safety controls can be implemented. The initial baseline air sampling results for each air sampling location will be added to the baseline asbestos exposure levels of 0.01 f/cc near the industrial areas, as established in the Office of Solid Waste and Emergency Response (OSWER) Directive #9200.0-68, Framework for Investigating Asbestos-Contaminated Superfund Sites (EPA 2008), to establish site action levels at each air sampling location.

The air sampling locations with analytical results exceeding 0.01 f/cc and their respective background results will be analyzed for the presence of asbestos at the direction of the EPA OSC via transmission electron microscopy (TEM) in accordance with NIOSH Method 7402, "Asbestos by TEM," to determine the concentration of airborne asbestos fibers in those air samples. The airborne asbestos fiber concentration will be reported in a phase contrast microscopy (PCM) equivalent of f/cc.

Table B-1 of Appendix B summarizes air samples to be collected, while a summary of sample containers, laboratory analyses, and other pertinent information is in Table B-2 of Appendix B.

Table B-3 of Appendix B specifies calibration, maintenance, and testing procedures for the high-volume sample pumps.

7.1.2. TSI DustTrak Air Monitor

START will also deploy a DustTrak at each air monitoring station to assess suspended particulates in real-time. The DustTrak units will be used in conjunction with a telemetry system (EPA Environmental Response Team's [ERT] VIPER) to record and monitor particulate levels in ambient air down to 0.1 microgram per cubic meter (µg/m^3). Particulate concentrations will be recorded as a 1-minute TWA for total particulates. Concentrations of particulate matter with diameters of 1, 2.5, 4, and 10 microns or less will be recorded but not processed and analyzed unless requested by the OSC.

Particulate monitors are factory calibrated and therefore do not require field calibration; however, particulate monitors require "zeroing" to ambient conditions, which will occur daily before use. START will periodically check the equipment to ensure it is properly operating and acquiring data. Real-time readings will be recorded on the device for download onto a computer at the end of the day, as well as through telemetry. When telemetry is used, particulate readings will be recorded continuously and regularly viewed throughout the day. Software used for telemetry will include ERT's VIPER system, in which a host computer and strategically placed relays will communicate real-time results throughout site activities. Data irregularities and problems will be identified and investigated. All data will be reviewed for accuracy at the end of each working day.

START will compare a 1-minute TWA for total particulate—as measured by the DustTrak and calculated by EPA ERT through VIPER—to the action level to determine if dust is traveling off-site and if mitigation methods are required. The action level for total particulates will be the National Ambient Air Quality Standard (NAAQS) of 150 µg/m^3.

Finally, if the 1-minute TWA for total particulate reaches and exceeds the action level, work will cease until implementation of dust suppression measures. The ERRS contractor will be responsible for dust suppression during removal activities. An alarm level of 100 µg/m^3 will notify START personnel of elevated particulate concentrations.

7.2. ADDITIONAL SAMPLING

Should sampling of media other than air be required at the direction of the OSC, the Tetra Tech SAP produced for the removal site assessment (Tetra Tech 2020a) will be referenced for sampling and analytical procedures. If the EPA OSC requests sampling methods or analyses not outlined in this AMP/SAP or the previous removal site assessment SAP, a revision will be made to this AMP/SAP accordingly.

7.2.1. Background Sampling

Prior to removal activities, Tetra Tech START will collect one low-volume and one high-volume air sample off-site in the upwind direction to be used as perimeter background air samples. The background samples will run for 8 hours.

The low-volume sample pump will be calibrated to approximately 2 to 2.5 liters per minute (L/min), and the high-volume sample pump will be calibrated to approximately 8 to 14.5 L/min. The samples will collect a minimum of 960 liters of air for the low-volume sample and a minimum of 4,000 liters of air for the high-volume sample.

7.2.2. Personnel Sampling

A personal air pump (such as a GilAir5) equipped with a 25-mm MCE filter cassette will be used to conduct sampling within the workers' PBZ while working with ACM or asbestos-contaminated material to collect air samples to be analyzed for asbestos. Representative 8-hour TWA samples of employees in the limited area will be collected periodically.

The pumps will be calibrated with a BIOS DryCal air flow calibrator to achieve a flow rate of approximately 2 to 2.5 L/min. Calibration will occur before each sampling event in accordance with Tetra Tech SOP No. 064-1, "Calibration of Air Sampling Pump" (Appendix C). The flow rate will be checked again for any change at the end of each sampling period. Sample collection information will be recorded on digital data forms. Samples will be collected approximately 4 to 5 feet above the ground to represent exposure in the PBZ. During sampling, the filter cassettes will be placed in a downward approximately 45-degree position with the inlet caps of the filter cassettes removed (open-faced) during sampling.

START will assist with sampling procedure and processing, then samples will be relinquished to Environmental Quality Management (EQM) Response Manager. Samples will be submitted by EQM to the EQM-procured laboratory for asbestos analysis in accordance with the guidelines established in 29 CFR 1926.1101 using NIOSH Method 7400, "Asbestos and Other Fibers by PCM." The laboratory analyzing the samples must participate in the American Industrial Hygiene Association (AIHA) Industrial Hygiene Proficiency Analytical Testing (IHPAT) program to ensure the results are within OSHA's quality assurance limits or as per other noted standards (EQM 2023).

29 CFR §1910.1001 sets an 8-hour TWA airborne concentration of 0.1 fiber (longer than 5 micrometers [µm] and having a length-to-diameter ratio of at least 3:1) per cubic centimeter (cm^3) of air (0.1 fiber/cm^3) for asbestos fibers, to include chrysotile, as determined by the membrane filter method at approximately 400X magnification with phase contrast illumination. No worker should be exposed to more than 1 fiber/cm^3 (excursion limit) as averaged over a sampling period of 30 minutes (EQM 2023). Personnel sample results will be managed and retained by EQM.

8. SAMPLE HANDLING

To properly document field data and characterize sampling conditions, START will use digital data capture technology with tablet computers equipped with the data acquisition application Survey123 and will record information in a field logbook and acquire photographic documentation. Survey123 is a data collection application that uses ArcGIS Collector to log details of samples in association with their geographic locations of collection. The sample date, time, sample type, field personnel initials, and sample collection location will be recorded in the field

START will note sampling locations in the site logbook in accordance with Tetra Tech SOP 024-4, "Recording Notes in Field Logbooks" (Appendix C). Sampling details will be recorded in the digital data collection applications as previously described. Collected samples will be labeled, packaged, and shipped in accordance with procedures outlined in Worksheets 26 and 27 of Tetra Tech's START QAPP (Tetra Tech 2022) and Tetra Tech's SOP 019-8, "Sample Packing and Shipping" (Appendix C).

9. SAMPLE NOMENCLATURE

Each sample will be labeled with the site identification (ID) (Nelson Knitting [NK]), sample description (perimeter air [PA], background [BK], work area [WK], or activity-based sample [ABS]), sample location number, sample number, and sampling date (“YYYYMMDD” format). For example, an ID for an air sample collected at perimeter station 1 at the Site on January 30, 2023, would be “NK-PA01-01-20230130.”

10. QUALITY ASSURANCE/QUALITY CONTROL

QA/QC procedures will depend on the medium sampled. The sections herein describe QA/QC procedures for air samples; general QA/QC protocols are provided in the Tetra Tech QAPP (Tetra Tech 2022). The START project manager will be responsible for ensuring maintenance of sample quality and integrity as well as adherence to the QAPP with respect to sample labeling and documentation procedures.

10.1. AIR SAMPLING

START will collect lot blank samples at a frequency of one per lot of cassettes. Additionally, START will collect field blanks at a frequency of one per day on days when asbestos samples are collected. A field blank will be a filter cassette opened and placed in a plastic bag, where it will remain throughout the perimeter air sampling event. After completing perimeter air sampling, the field blank will be sealed and submitted for the same laboratory analysis as other air samples. Samples will be stored upright (that is, the caps for the top and bottom align with the top and bottom of the container) in a secured, climate-controlled location under a chain of custody. Samples will be sent to the laboratory for analysis upon the request of the OSC. Upon OSC request for laboratory analysis, the specified samples will be sent to the laboratory, and any additional samples that were packaged with those samples will once again be placed under a chain of custody.

10.2. POTENTIAL MATERIAL SAMPLING

For any other sampled media, the Tetra Tech SAP produced for the RSE (Tetra Tech 2020a) will be referenced for coinciding QA/QC procedures.

11. DECONTAMINATION

Any disposable sampling equipment and personal protective equipment (PPE) will be double bagged for disposal as dry industrial waste. Equipment will undergo a gross decontamination with deionized water in accordance with Tetra Tech SOP No. 002-5, “General Equipment Decontamination.” A wet wipe may be used to decontaminate the air sampling pumps. All investigation-derived waste (IDW) will be double-bagged and disposed of as dry industrial waste. Air sampling equipment (pumps and tubing) does not contact the sample and will not require decontamination.

12. REFERENCES

City of Rockford. 2020. E-mail. *Nelson Knitting – 909 S Main St, Rockford, IL.* From: Robert Wilhelmi, City of Rockford. To: Ramon Mendoza, EPA. June 29.

Environmental Quality Management, Inc. (EQM). 2023. "Site Specific Health and Safety Plan, Time-Critical Removal, Nelson Knitting Site, Rockford, Winnebago County, Illinois." January.

Fehr-Graham Associates (FGA). 2008. *Phase I Environmental Site Assessment, Former Nelson Knitting Mills.* July 30.

FGA. 2009. *Phase I Environmental Site Assessment Update and Phase II Environmental Site Assessment, Former Nelson Knitting Mills*. July 9.

Tetra Tech, Inc. (Tetra Tech). 2020a. "Abbreviated Sampling and Analysis Plan Revision 0." Prepared for EPA under Contract No. 68-HE-0519-D0005. October.

Tetra Tech. 2020b. "Removal Site Evaluation Report Revision 1." Prepared for EPA under Contract No. 68-HE-0519-D0005. December.

Tetra Tech, Inc. (Tetra Tech). 2022. "Quality Assurance Project Plan (QAPP), Superfund Technical Assessment and Response Team (START V), Revision 3." U.S. Environmental Protection Agency Region 5, Solicitation No. 68HE0519D005. January.

U.S. Environmental Protection Agency (EPA). 2008. "Framework for investigating asbestos-contaminated Superfund sites." OSWER Directive: 9200.0-68. September.

EPA. 2022. "Action Memorandum - Request for Approval and Funding of a Time-Critical Removal Action at the Nelson Knitting Site, Rockford, Winnebago County, Illinois (Site ID # C5RT)." November.

APPENDIX A. FIGURES

Figure 1 – Site Location Map

Figure 2 – Site Layout Map

Figure 3 – Proposed Air Monitoring and Sampling Locations

APPENDIX B. TABLES

Table B-1 — Air Sample Summary

Table B-2 — Analytical Methods

Table B-3 — Field Equipment Calibration, Maintenance, Testing, and Inspection

Table B-1 — Air Sample Summary

Analytical Parameter	Analytical Method	Number of Perimeter Monitoring Samples[1]	Number of Lot Blanks	Number of Blanks (Field or Equipment)[2]	Total Number of Samples for Laboratory Analysis[3]
Asbestos	PCM - NIOSH 7400 TEM - NIOSH 7402	60	2	30	92

Notes:
[1]It is estimated that two samples will be collected per day of removal activities. A project duration of approximately 30 removal days would require 60 samples.
[2]The total assumes one lot blank sample per 50 air samples and one field blank per day.
[3]This is the number of samples that could be submitted if asbestos work is conducted every working day.

NIOSH: National Institute for Occupational Safety and Health
PCM: Phase contrast microscopy
TEM: Transmission electron microscopy

Table B-2 — Analytical Methods

Matrix	Parameter	Analytical Method	Volumes and Containers	Preservation	Holding Time[1]
Air	Asbestos	PCM - NIOSH 7400 TEM - NIOSH 7402	0.8-micron cellulose ester membrane	NA	NA

Notes:
[1]Holding time is measured from the time of sample collection to the time of sample extraction and analysis.

NA: Not applicable
NIOSH: National Institute for Occupational Safety and Health
PCM: Phase contrast microscopy
TEM: Transmission electron microscopy

Table B-3 — Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Calibration Activity	Maintenance Activity	Testing/ Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person
TSI DustTrak Air Monitor	Zero unit in ambient air	Clean inlet, calibration impactor, and replace internal filter	Zero calibrate, clean unit	Prior to each day's activity or when any anomaly is suspected	NA	Repeat calibration; service if calibration issues persist	Equipment vendor
Gilian AirCon2 Air Sampling Pump	Adjust flow rate to approximately 14 liters per minute	Check pump flow with Bios calibrator to ensure appropriate flow	Check flow upon completion of day's activity	Prior to each day's activity	Calibration acceptable within 8–14.5 liters per minute	Repeat calibration; service if calibration issues persist	Equipment vendor
GilAir 5 Sampling Pump	Adjust flow rate to approximately 4 liters per minute	Check pump flow with Bios calibrator to ensure appropriate flow	Check flow upon completion of day's activity	Prior to each day's activity	Calibration acceptable within 3-4 liters per minute	Repeat calibration; service if calibration issues persist	Equipment vendor
SKC QuickTake 30	Adjust flow rate to approximately 10 liters per min	Check pump flow with Bios calibrator to ensure appropriate flow	Check flow upon completion of day's activity	Prior to each day's activity	Calibration acceptable within 9–11 liters per minute	Repeat calibration; service if calibration issues persist	Equipment vendor

Notes:
%: percent
±: plus or minus
NA: Not applicable

APPENDIX C. TETRA TECH, INC. ENVIRONMENTAL STANDARD OPERATING PROCEDURES (SOP)

SOP 002-5 — "General Equipment Decontamination"

SOP 019-8 — "Sample Packing and Shipping"

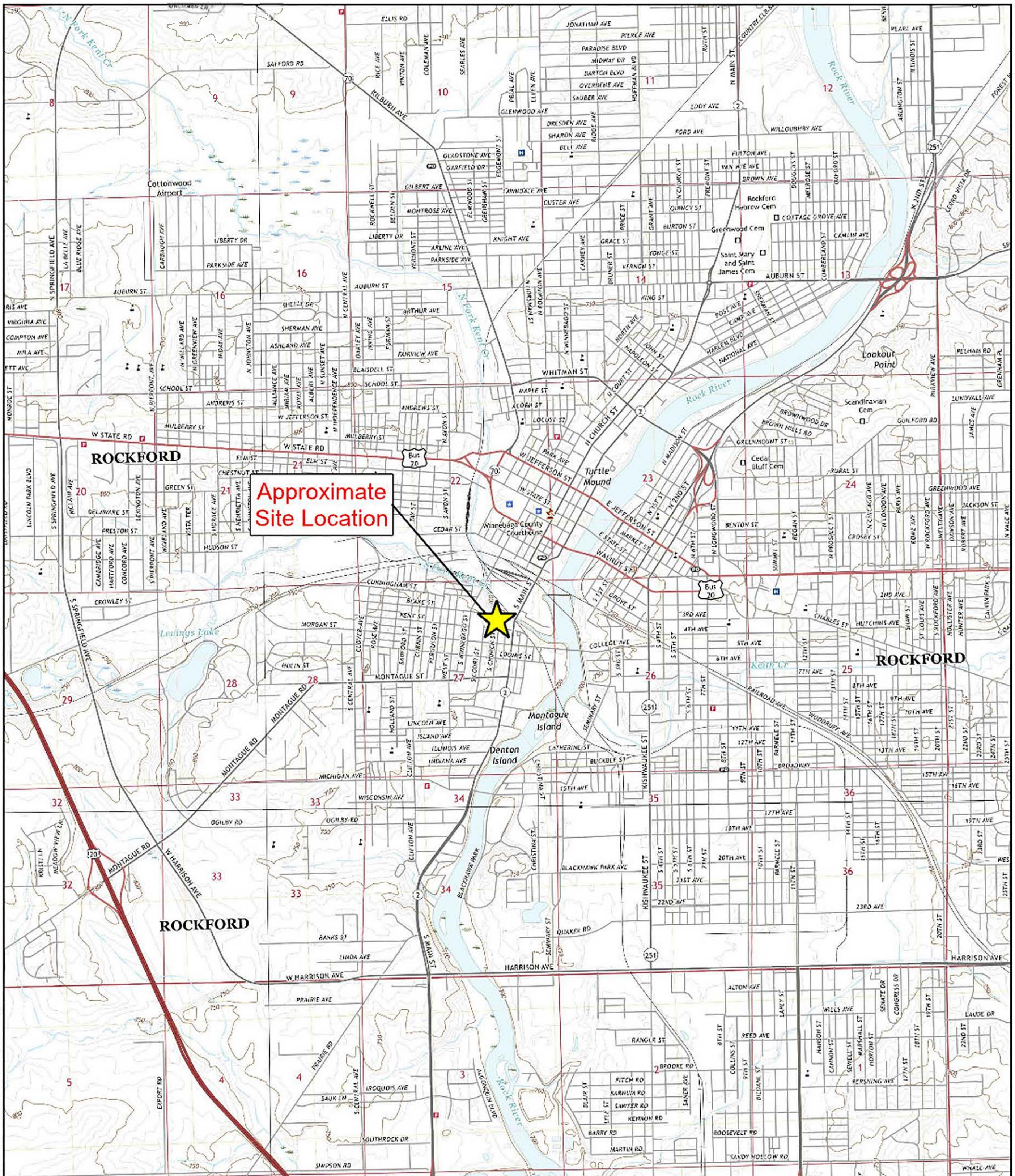
SOP 024-4 — "Recording Notes in Field Logbooks"

SOP 064-1 — "Calibration of Air Sampling Pump"

ATTACHMENT 1. EPA ENVIRONMENTAL RESPONSE TEAM (ERT) SOPS

ERT SOP 2015 – "Asbestos Air Sampling"

ERT SOP 2084 – "Activity-Based Sampling for Asbestos"



Legend

☆ Approximate Site Location

N

0 2,000 4,000

Feet

Source: USGS Winnebago, IL 7.5 Minute Topo Quad, 2021
USGS Kishwaukee, IL 7.5 Minute Topo Quad, 2021
USGS Rockford North, IL 7.5 Minute Topo Quad, 2021
USGS Rockford South, IL 7.5 Minute Topo Quad, 2021

Nelson Knitting Site - RV
909 South Main Street
Rockford, Winnebago County, Illinois

Figure 1
Site Location Map

TETRA TECH

Prepared For: US EPA

Prepared By: Tetra Tech, Inc.

C:\Users\JORDAN.EDMUNDS\Documents\ArcGIS\Projects\Nelson Knitting Removal\Nelson Knitting Removal.aprx

Date: 01/19/2023

EPA Contract No.: 68HE0519D0005

TO-TOLIN: F0032-0001DL101

Coordinate System: WGS 1984
Datum: D 1984
Units: Degrees

Reference Map

Legend

Approximate Site Boundary

N

0 50 100

Feet

Source: Google Earth

Nelson Knitting Site - RV
909 South Main Street
Rockford, Winnebago County, Illinois

Figure 2
Site Layout Map

TETRA TECH

Prepared For: US EPA

Prepared By: Tetra Tech, Inc.

Date: 01/19/2023

EPA Contract No.: 68HE0519D0005

TO-TOLIN: F0032-0001DL101

Coordinate System: WGS 1984
Datum: D 1984
Units: Degrees

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Reference Map

Legend

- Air Monitoring Location
- Approximate Site Boundary

N

0 50 100

Feet

Source: Google Earth

Nelson Knitting Removal Site
909 South Main Street
Rockford, Winnebago County, Illinois

Figure 3
Proposed Air Monitoring Location Map

TETRA TECH

Prepared For: US EPA

Prepared By: Tetra Tech, Inc.

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Date: 01/19/2023

EPA Contract No.: 68HE0519D0005

TO-TOLIN: F0032-0001DL101

Coordinate System: WGS 1984
Datum: D 1984
Units: Degrees

SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 002

REVISION NO. 5

Last Reviewed: August 2021

Carla Buriks

Quality Assurance Approved

August 2021

Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. All sampling equipment must be thoroughly cleaned before each use to prevent contamination of samples.

1.3 DEFINITIONS

Alconox: Phosphate-containing soap, obtained in powder form and dissolved in water

Deionized (DI) Water: DI water is water that has been treated to remove all ions – typically, that means all of the dissolved mineral salts and metal ions.

Liquinox: Phosphate-free soap, obtained in liquid form for mixing with water

Luminox: Specialized detergent with the capability of removing oils and organic contamination, also phosphate-free and liquid

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992. "RCRA Ground-Water Monitoring: Draft Technical Guidance." Office of Solid Waste. Washington, DC. EPA/530 R 93 001. November.

EPA. 2020a. "Management of Investigation-Derived Waste." LSASDPROC-202-R4. May 8. https://www.epa.gov/quality/management-investigation-derived-waste

EPA. 2020b. "Field Equipment Cleaning and Decontamination." LSASDPROC-205-R4. June 22. https://www.epa.gov/sites/production/files/2016-01/documents/field_equipment_cleaning_and_decontamination205_af.r3.pdf

1.5 REQUIREMENTS AND RESOURCES

The equipment and supplies to conduct decontamination may include the following:

- Scrub brushes

- Large wash tubs or buckets
- Squirt or spray bottles
- Alconox or Liquinox (Note: Alconox contains phosphates, and phosphates have been banned in many household cleaning products based on their adverse effect on the environment.)
- Tap water
- Distilled water
- DI water
- Plastic sheeting
- Aluminum foil
- Isopropanol (laboratory grade) or Luminox

2.0 PROCEDURES

This section describes procedures for decontamination of personal protective equipment (PPE) as well as equipment for drilling and monitoring well installation, borehole soil sampling, general sampling, water level measurement, and groundwater sampling. PPE (as outlined in the site-specific health and safety plan) should be used during decontamination procedures. Special handling of used PPE and wastewater generated from decontamination procedures may be required if the type of contamination is considered hazardous according to the Resource Conservation and Recovery Act (RCRA).

Any special handling should also be outlined in the site-specific health and safety plan or the sampling and analysis plan. At a minimum, no eating, drinking, smoking, or any other hand-to-mouth contact should be allowed during decontamination activities.

Some clients may have additional requirements for decontamination procedures. For example, phosphate-free detergent may be a requirement and, therefore, it would not be appropriate to use Alconox.

Source water for decontamination should be selected based on site-specific conditions and contaminants. In general, laboratory DI water is preferred for decontamination of instruments and sampling devices. Standard distilled water, readily available at grocery stores, may be appropriate at other times. However, distilled water may still contain unacceptable levels of inorganic ions. Decontamination of heavy equipment such as drill rigs will typically use tap water or similar source water, often used in combination with a steam or hot-water cleaning unit. During procurement, Tetra Tech personnel should specify the source of decontamination water to be used by the subcontractors and ensure that it is consistent with investigation goals. Refer to the site-specific sampling and analysis plan for details concerning source water.

In general, conduct field activities to move from cleaner to more contaminated locations to minimize the potential for cross contamination between locations.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off site or to clean areas. Refer to the site-specific health and safety plan as the first resource for types of PPE; not all types of PPE nor methods for decontamination discussed below will be appropriate for every site. All used disposable protective clothing, such as Tyvek, coveralls, gloves, and booties, will be containerized for later disposal.

Decontamination water will be containerized in 55-gallon drums or similar sealable containers (refer to Section 3.0).

Personnel decontamination procedures will be as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.

2. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.

3. Remove outer gloves and place into plastic bag for disposal.

4. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for laundry before reuse.

5. Remove air purifying respirator (APR), if used, and place the spent filters in a plastic bag for disposal. Filters should be changed daily or sooner, depending on use and application. Place the respirator into a separate plastic bag after it has been cleaned and disinfected according to the instructions for the respirator.

6. Remove disposable gloves and place them in plastic bag for disposal.

7. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated at a designated location on site before drilling operations begin, between borings, and at completion of the project. Decontamination may be conducted on a temporary decontamination pad constructed at a satellite location within the site. The purpose of the decontamination pad is to contain wash waters and potentially contaminated soil generated during decontamination procedures. Decontamination pads may be constructed of concrete, wood, or plastic sheeting, depending on the site-specific needs and plans. Wash waters and contaminated soil generated during decontamination should be considered investigation-derived waste (IDW) and, thus, should be collected and containerized for proper disposal.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they may be steam cleaned and placed on polyethylene sheeting on site before they are used downhole, if required by the site-specific work plan. The drilling subcontractor will typically furnish the steam cleaner and water.

The drilling auger, bits, drill pipe, any portion of drill rig that is over the borehole, temporary casing, surface casing, and other equipment used in or near the borehole should be decontaminated by the drilling subcontractor as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Remove loose soil using shovels, scrapers, wire brushes, and any related material.
3. Steam clean or pressure wash to remove all visible dirt. Use appropriate PPE (for example, a face shield and Tyvek/coveralls) as necessary.
4. If equipment has directly or indirectly contacted contaminated media and is known or suspected of being contaminated with oil, grease, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), or other hard-to-remove organic materials, rinse equipment with laboratory-grade isopropanol or Luminox solution.
5. To the extent possible, allow components to air dry; drying helps limit the spread of contamination through contact. Equipment should be dried and stored upwind of contaminated areas to minimize potential cross-contamination.
6. All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING DOWNHOLE EQUIPMENT DECONTAMINATION AND GENERAL SOIL SAMPLING EQUIPMENT DECONTAMINATION

All soil sampling equipment should be decontaminated before use and after each sample as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Scrub the split-barrel sampler and sampling tools in a wash bucket or tub using a stiff, long-bristle brush with a solution of tap water with Liquinox or Alconox.
3. Rinse equipment thoroughly with tap water or distilled water.
4. Perform a final rinse with DI or distilled water. Refer to the site-specific sampling and analysis plan for requirements for DI or distilled water.
5. Place cleaned equipment in a clean area on plastic sheeting or aluminum foil and allow to air-dry. Clean, dry equipment should be stored in clean equipment cases to minimize potential cross-contamination. If the equipment does not have a case, it should be stored on a clean surface upwind of contaminated areas to minimize potential cross-contamination.
6. Containerize all water and rinsate; also, containerize disposable, single-use sampling equipment.

2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the water-level indicator or interface probe before inserting and after removing it from each well. The following decontamination procedures should be used:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Wipe the tape and probe with a disposable Alconox- or Liquinox-impregnated cloth or paper towel. Spray the probe with Alconox or Liquinox solution to ensure that all ports on the probe are cleaned.
3. If immiscible layers are encountered, the interface probe may require steam cleaning or washing with laboratory-grade isopropanol or Luminox solution.
4. Rinse with distilled or deionized water, including spraying the probe with rinse water.
5. Store clean, dry equipment in clean equipment cases to minimize potential cross-contamination. If the equipment does not have a case, it should be stored on a clean surface upwind of contaminated areas to minimize potential cross-contamination.
6. Containerize all water and rinsate for proper disposal.

2.5 GROUNDWATER SAMPLING EQUIPMENT

The following procedures are to be employed to decontaminate equipment used for groundwater sampling. Decontamination is not necessary when using disposable (single-use) or dedicated (reused but only at a single sample point) pump tubing or bailers. Decontamination procedures for reused equipment are described below.

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Remove and containerize any purge water in the pump and tubing and dispose of tubing.
3. Dismantle the pump as much as possible and scrub components in a wash bucket or tub using a stiff brushes of appropriate size with a solution of tap water with Liquinox or Alconox.
4. Rinse pump components thoroughly with tap water or distilled water.
5. If groundwater contains or is suspected to contain oil, grease, PAHs, PCBs, or other hard-to-remove organic materials, rinse the pump and tubing with laboratory-grade isopropanol or Luminox solution.
6. Perform a final rinse with DI or distilled water.
7. Allow components to air dry.
8. Wrap pump in aluminum foil or a clean plastic bag for storage.
9. Containerize the used tubing and decontamination wash waters for proper disposal.

3.0 INVESTIGATION-DERIVED WASTE

IDW can include disposable, single-use PPE and sampling equipment, soil cuttings, purge water, and decontamination wash waters and sediments. Requirements for waste storage may differ from one facility to the next. Facility-specific directions for waste storage will be provided in project-specific documents, or separate direction will be provided by the project manager. Make sure to consult with a qualified professional before making any waste characterization decisions. The following guidelines are provided for general use:

1. Assume that all IDW generated from decontamination contains the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. Waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.

2. Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility.

3. Label IDW storage containers with the facility name and address, date, contents, company generating the waste, and an emergency contact name and phone number.

4. Temporarily store the IDW in a protected area that provides access to the containers and allows for spill/leak monitoring, sampling of containers, and removal after the disposal method has been identified.

SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

PACKAGING AND SHIPPING SAMPLES

SOP NO. 019

REVISION NO. 8

Last Reviewed: August 2020

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Date

1.0 BACKGROUND

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. This standard operating procedure (SOP) describes procedures for packaging and shipping samples. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples.

1.1 PURPOSE

This SOP establishes the requirements and procedures for packaging and shipping nonhazardous environmental samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) "Contract Laboratory Program Guidance for Field Samplers." Procedures described in this SOP should be followed for all routine sample packaging and shipping of nonhazardous samples. If procedures are to be modified for particular contract- or laboratory-specific requirements, modified procedures should be clearly described in site-specific plans such as work plans, field sampling plans (FSP), or quality assurance project plans (QAPP). Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already in the appropriate sample jars and that the sample jars are labeled.

This SOP does not cover the packaging and shipment of Dangerous Goods or Hazardous Materials. The shipment of Dangerous Goods (by air) and Hazardous Materials (by ground) requires specialized training. If you have NOT received this training in the last 2 years, you are NOT qualified to package or ship these materials and may be personally liable for any damages or fines. Contact one of Tetra Tech's shipping experts for assistance. Instructions to access the training course, shipping experts, and health and safety (H&S) contacts, and general information on packaging and shipping hazardous substances and dangerous goods can be obtained by checking the links provided in Section 1.4 (References) and communicating with appropriate Tetra Tech H&S contacts listed on the EMI Operating unit internal H&S web site.

1.2 SCOPE

This SOP applies to packaging and shipping of environmental and nonhazardous samples. This SOP does not address shipping dangerous goods or hazardous materials.

1.3 DEFINITIONS

Airbill: An airbill is a shipping form (such as a FedEx shipping form) acquired from the commercial shipper and is used to document shipment of the samples from the sampler to the designated analytical laboratory (see Figure 1).

Blank: A blank is any sample that is used to assess cross-contamination from sampling and sample management procedures. A typical blank sample will consist of distilled or deionized (DI) water (water sampling) or an air filter cartridge (air sampling) that is then analyzed by the laboratory to evaluate whether cross-contamination has been introduced. Each blank is assigned its own unique sample number. Blanks collected in the field include trip blanks, field blanks, and equipment blanks, all intended to assess potential cross-contamination. For example, a trip blank checks for contamination during sample handling, storage, and shipment from the field to the laboratory. Field blanks assess the contamination of water or soil from ambient air. Equipment blanks (also known as rinse blanks) assess contamination from incomplete decontamination procedures.

Chain-of-Custody form: A chain-of-custody form is used to document the transfer of custody of samples from the field to the designated analytical laboratory (see Figure 2). The chain-of-custody form is critical to the chain-of-custody process and is used to identify the samples in each shipping container to be shipped or delivered to the laboratory for chemical or physical (geotechnical) analysis. A copy of the chain-of-custody form is shipped with the samples and accompanies them from sampler to laboratory (see Figure 3).

Custody seal: A custody seal is a tape-like seal and is used to indicate that samples are intact and have not been disturbed during shipping or transport after the samples have been released from the sampler to the shipper (see Figure 4). The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping (see Figure 5).

Environmental samples: Environmental samples include drinking water, groundwater, surface water, soil, sediment, treated municipal and industrial wastewater effluent, indoor and ambient air, nonhazardous bulk materials, soil gas, dust, asbestos, and biological specimens. Environmental samples typically contain low concentrations of contaminants and, when handled, require only limited precautionary procedures.

Nonhazardous samples: Nonhazardous samples are those samples that do not meet the definition of a hazardous sample AND do not need to be packaged and shipped in accordance with the International Air Travel Association's (IATA) "Dangerous Goods Regulations" (DGR) or U.S. Department of Transportation's "Hazardous Materials Regulations" defined in Title 49 *Code of Federal Regulations* (CFR).

The following definitions are provided to further distinguish environmental and nonhazardous samples from dangerous goods and hazardous samples:

Dangerous goods: Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 2020).

Hazardous samples: Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the Hazardous Material Regulations.

Hazardous substance: A hazardous substance is any material, including its mixtures and solutions, that is listed in 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity listed in Table 1 to Appendix A of 49 CFR 172.101.

1.4 REFERENCES

General Awareness, H&S Contacts, and Course Training Information (Tetra Tech, Inc., EMI Operating Unit. Intranet) On-line address: https://int.tetratech.com/sites/EMI/hs/Pages/Dangerous-Goods-Shipping.aspx

International Air Transport Association (IATA). 2020. "Dangerous Goods Regulations. 2020." For sale at: https://www.iata.org/en/publications/dgr/. Updated annually, with new edition available late in year.

U.S. Environmental Protection Agency (EPA). 40 CFR, 763 Subpart F, Asbestos Hazards Emergency Response Act (AHERA).

EPA. 2014. "Contract Laboratory Program Guidance for Field Samplers." EPA 540-R-014-013. October. On-line address: https://www.epa.gov/sites/production/files/2015-03/documents/samplers_guide.pdf.

EPA. 2020. "Packing, Marking, Labeling and Shipping of Environmental and Waste Samples." EPA Region 4, LSASDPROC-209-R4. February 23. On-line address: https://www.epa.gov/sites/production/files/2015-06/documents/Shipping-Environmental-and-Waste-Samples.pdf

1.5 REQUIREMENTS AND RESOURCES

The procedures for packaging and shipping samples require the following:

- Coolers (insulated ice chest) or other shipping containers appropriate to sample type
- Ice
- Bubble wrap or similar cushioning material
- Chain-of-custody forms and seals
- Airbills

- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)
- Large plastic garbage bags for lining the cooler
- Temperature blank sample bottle filled with distilled water can be included in the cooler if appropriate to sample type
- Trip blank samples used to check for volatile contamination during sample handling in the field should accompany sample containers during shipment from laboratory to field (empty containers) and from field to laboratory (filled containers). It should remain in the cooler with sample containers during the sampling event. Trip blanks should be requested from the laboratory when containers are initially ordered.

2.0 PROCEDURES

The following procedures apply to packaging and shipping nonhazardous and environmental samples.

2.1 PACKAGING SAMPLES

After they have been appropriately containerized and labeled, environmental samples should be packaged as described in this section. This section covers procedures for packing samples for delivery by commercial carrier (air or ground) and hand delivery of environmental samples (by employee or courier), as well as shipping asbestos and air quality samples. Note that these instructions are general; samplers also should be aware of client-specific requirements concerning the placement of custody seals or other packaging provisions.

2.1.1 Packaging Samples for Delivery by Commercial Carrier (Air or Ground)

Samples shipped by commercial carriers should be packed for shipment using the following procedures and in compliance with all carrier requirements:

Preparing the sample:

1. Allow a small amount of headspace in all bottles, or as instructed by the laboratory (except volatile organic compound [VOC] containers with a septum seal) to compensate for any changes in pressure and temperature during transfer.

2. Be sure the lids on all bottles are tight (will not leak). Lids maybe taped or sealed with custody seals as added protection or as required. For any sample containers that are not marked with a tare weight by the laboratory, cover the completed sample label on the container with clear tape to protect the label.

3. Place sample containers in resealable plastic bags.

Preparing the cooler:

1. Secure and tape the drain plug of the cooler with fiber or duct tape.

2. Line the cooler with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.

3. Wrap the sample containers in bubble wrap or line the cooler (bottom and sides) with a cushioning material to prevent breakage of bottles or jars during shipment.

4. If required by the laboratory for the analytical method, add a sufficient quantity of ice to the cooler to cool samples to 4 °C (± 2 °C). Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. If required, include one temperature blank (a sample bottle filled with distilled water) per cooler.

5. For VOC samples only, include one trip blank for VOC analysis per shipment matrix in each cooler.

6. Fill all remaining space between the bottles or jars with bubble wrap.

7. As each container is placed in the cooler, verify the sample information on the chain-of-custody form. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler.

8. Securely fasten the top of the large garbage bag with tape (preferably plastic electrical tape).

9. If more than one cooler is being shipped, mark each cooler as "1 of 2," "2 of 2," and so forth.

10. Place the chain-of-custody forms (see Figure 2) into a resealable plastic bag, and tape the bag to the inner side of the cooler lid (see Figure 3). If you are shipping more than one cooler, copy the chain-of-custody form so that there is one copy of all forms in each cooler. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler. Tape any instructions for returning the cooler to the inside of the lid.

11. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once.

12. Place two signed custody seals (see Figure 4) on opposite sides of the cooler, ensuring that each one covers the cooler lid and side of the cooler (see Figure 5; note that in contrast to the figure, the seals should be placed on the opposite sides of the cooler and offset from each other, rather than directly across from each other as shown in Figure 5). Place clear plastic tape over the custody seals so that the cooler cannot be opened without breaking the seal.

13. Shipping containers should be marked "THIS END UP." Arrow labels, which indicate the proper upward position of the container, may also be affixed to the container. As appropriate, the containers should also be labeled for Saturday delivery or other special requirements.

14. Ship samples overnight using a commercial carrier such as FedEx. As a best practice, electronic sample shipping labels should be prepared by the shipping agency's employees, at the direction of Tetra Tech employees or sampling personnel. This allows the sampling personnel to confirm special shipping requirements, such as Saturday delivery, and verify that samples will be shipped that day (that is, the last shipment of the day has not already occurred). If this is not possible, the airbill can be prepared by hand (see Figure 1), but samples should still be handed over directly to shipping agency employees and shipping details should be verified. The shipping label should be placed on the outside of the container.

15. A copy of the receipt with sample tracking number should be retained by the sampling personnel and delivery should be verified the next day.

2.1.2 Hand Delivery of Environmental Samples (by Employee or Courier)

Samples hand-delivered to the laboratory should be packed for shipment using the following procedures:

Preparing the sample:

1. Bottles can be filled completely with sample (required for VOC containers with a septum seal).

2. Be sure the lids on all bottles are tight (will not leak).

Preparing the cooler:

1. Secure and tape the drain plug of the cooler with fiber or duct tape.

2. Wrap the sample containers in bubble wrap or line the cooler (bottom and sides) with a cushioning material to prevent breakage of bottles or jars during shipment.

3. As each container is placed in the cooler, verify the sample information on the chain-of-custody form. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler.

4. If required for by the laboratory for the analytical method, add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. If required, include one temperature blank (a sample bottle filled with distilled water) per cooler.

5. For VOC samples only, include one trip blank for VOC analysis per shipment matrix in each cooler.

6. If more than one cooler is being shipped, mark each cooler as "1 of 2," "2 of 2," and so forth.

7. Place the chain-of-custody form (see Figure 2) in a resealable plastic bag and tape to the inside of the cooler lid (see Figure 3), close the lid, and seal with custody seals (see Figure 5; note that in contrast to the figure, the seals should be placed on the opposite sides of the cooler and offset from each other, rather than directly across from each other as shown in Figure 5). Place clear plastic tape over the custody seals so that the cooler cannot be opened without breaking the seal. Transfer the cooler to the courier. When samples will be delivered directly to the laboratory, it is sufficient to close the cooler and hand-deliver it with the chain-of-custody form.

8. Include any instructions for returning the cooler to the inside of the lid.

9. If the cooler is being transferred to a courier, the shipping containers should be marked "THIS END UP," and arrow labels, which indicate the proper upward position of the container should be affixed to the container.

2.1.3 Shipping Asbestos Samples

Asbestos samples shipped by commercial carriers should be packed for shipment using the following procedures and in compliance with all carrier requirements:

1. Place each asbestos sample in a small resealable plastic bag or Whirl-pak sealable bag. Seal the bags carefully and place the sample bags in a larger resealable plastic bag.

2. Select a rigid shipping container and pack the samples upright in a noncontaminating, nonfibrous medium such as a bubble pack to minimize excessive movement during shipping.

3. Avoid using expanded polystyrene because of its static charge potential. Also avoid using particle-based packaging materials because of possible contamination.

4. Affix custody seals to the samples or outer sample bag so that the bags cannot be opened without breaking the seal.

5. Insert the chain-of-custody form in the box. Include a shipping bill and a detailed listing of samples shipped, their descriptions and all identifying numbers or marks, sampling data, shipper's name, and contact information.

6. Ship bulk samples in a separate container from air samples. Bulk samples and air samples delivered to the analytical laboratory in the same container will be rejected.

7. For each sample set, designate which are the ambient samples, which are the abatement area samples, which are the field blanks, and which is the sealed blank if sequential analysis is to be performed.

8. Hand-carry samples to the laboratory in an upright position if possible; otherwise, choose that mode of transportation least likely to shake the samples in transit.

9. Address the package to the laboratory sample coordinator by name when known and alert him or her of the package description, shipment mode, and anticipated arrival as part of the chain-of-custody and sample tracking procedures. This information will also help the laboratory schedule timely analysis for the samples when they are received.

2.1.4 Shipping Air Samples

Packaging and shipping requirements for air samples vary depending on the media used to collect the samples and the analyses required. Sampling media typically include Summa canisters and Tedlar bags for whole air samples, filters for metals and particulate matter, and sorbent tubes for organic contaminants. This section of the SOP provides general guidelines for packaging and shipping air samples collected using these media. The project FSP or QAPP should also be reviewed for any additional project-specific requirements or instructions.

Summa Canister Samples

1. Close the canister valve by tightening the knob clockwise or flipping the toggle switch. Replace the brass cap on the canister inlet.

2. If a flow controller was used to collect the air sample over a specified time interval, the flow controller should be removed before replacing the brass cap.

3. Fill out the sample tag on the canister with the sample number and the date and time of collection. Include the identification number of the flow controller on the sample tag if one was used. Make sure the information on the sample tag matches the chain-of-custody form.

4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final Summa canister vacuum readings; Summa canister identification number; and flow controller identification number.

5. Package the Summa canister (and flow controller) in its original shipping box with the original packaging material. Tape the box shut and apply custody seals if required. Note: Summa canisters should never be packaged with ice.

6. Summa canister shipments typically include several canisters, and may include more than one shipping box. The chain-of-custody form for the shipment should be sealed within one of the shipping boxes. If more than one box is being shipped, mark each box as "1 of 2," "2 of 2," and so forth.

7. Ship the samples by a method that will meet the holding time. Summa canister samples should be analyzed within 30 days of sample collection.

Tedlar Bag Samples

1. Before removing it from the sample port, close the Tedlar bag by tightening the valve clockwise. The bag should only be approximately half-full to allow for pressure changes during shipping and handling of the sample. Keep the Tedlar bag out of direct sunlight to preserve the sample.

2. Fill out the label on the bag with the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.

3. Complete the chain-of-custody form.

4. Package the Tedlar bag in a shipping box with appropriate packing material to prevent the bag from being punctured or damaged. Multiple bags can be packaged in the same box. Tape the box shut and apply custody seals if required. Note: Tedlar bag samples should not be cooled or packaged with ice, although they can be shipped in an ice chest to protect the samples.

5. Tedlar bag shipments may include more than one shipping box. The chain-of-custody form for the shipment should be sealed within one of the shipping boxes. If more than one box is being shipped, mark each box as "1 of 2," "2 of 2," and so forth.

6. Ship the samples using priority overnight delivery. Tedlar bag samples should be analyzed within 3 days of sample collection.

Filter Cassette Samples

1. Disconnect the filter cassette from the air sampling pump and replace the plastic caps on the inlet and outlet openings.

2. Attach a label to the sample that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.

3. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.

4. Package the filter cassettes in a shipping box (such as a FedEx box). Use an appropriate packing material (such as bubble wrap) to separate the samples and prevent damage.

5. Place the chain-of-custody form within the box, seal the box, and apply custody seals if required. Filter cassette samples typically do not need to be cooled, but check the field sampling plan (FSP) or Quality Assurance Project Plan (QAPP) for project-specific requirements.

6. Ship the samples by a method that will meet the holding time.

Sorbent Tube Samples

1. Disconnect the sample tube from the air sampling pump and seal both ends of the tube with plastic caps.

2. Complete a sample label that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.

3. If the tube is small and the label cannot be attached to the tube, the tube can be placed in a small resealable plastic bag and the label can be attached to the bag or placed inside the bag with the tube.

4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.

5. Packaging requirements for the sample tubes will depend on the analysis required, and the sampler should check the FSP or QAPP for project-specific requirements (for example, tubes may need to be wrapped in aluminum foil to prevent exposure to light). Packaging containers and methods include (1) shipping boxes (as described under filter cassette samples), (2) small sample coolers filled with double-bagged ice, and (3) small sample coolers filled with blue (reusable) ice.

6. Place the chain-of-custody form within the box or container, seal the box or container, and apply a custody seal if required.

7. If coolers are used for shipping, tape instructions for returning the cooler to the inside of the lid.

8. Ship the samples by a method that will meet the holding time.

Polyurethane Foam (PUF) Tube Samples

1. Disconnect the PUF tube from the air sampling pump and wrap the tube in aluminum foil.

2. Attach a label to the wrapped sample tube that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.

3. Wrap the PUF tube in bubble wrap and place the tube in a glass shipping jar.

4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.

5. Package the PUF tube jars in a cooler that is filled with double-bagged ice. Use bubble wrap or other cushioning material to separate the samples and prevent breakage.

6. Place the chain-of-custody form within the cooler, seal the cooler, and apply a custody seal if required.

7. If coolers are used for shipping, tape instructions for returning the cooler to the inside of the lid.

8. Ship the samples by a method that will meet the holding time. Samples collected in PUF tubes typically must be extracted within 7 days of collection.

2.2 SHIPPING DOCUMENTATION FOR SAMPLES

Airbills, chain-of-custody forms, and custody seals must be completed for each shipment of nonhazardous environmental samples.

Field staff collecting samples should also review their field work plans to confirm what documentation must be completed during each sampling event, including client-specific requirements. For example, some EPA programs have a specific requirement to use Scribe software, an environmental data management system, to create sample documentation, electronically input information into Traffic Report or chain-of-custody forms, and enter other data.

- The Scribe software can be accessed from the EPA Environmental Response Team (ERT) at the following address: http://www.ertsupport.org/scribe_home.htm
- The ERT User Manual for Scribe, reference, and training materials can be accessed from the Scribe Support Web site at the following address: http://www.epaosc.org/scribe

Note that some laboratories must routinely return sample shipping coolers within 14 calendar days after the shipment has been received. Therefore, the sampler should also include instructions for returning the cooler with each shipment, when possible. The sampler (not the laboratory) is responsible for paying for return of the cooler and should include shipping airbills bearing the sampler's shipping account number, as well as a return address to allow for return of the cooler. Samplers should use the least expensive option possible for returning coolers.

2.3 SHIPMENT DELIVERY AND NOTIFICATION

A member of the field sampling team must contact the laboratory to confirm it accepts deliveries on any given day, especially Saturdays. In addition, samplers should ensure the laboratory has been notified in advance of the pending shipment and notify any additional parties as required. The sampler needs to know the laboratory's contact name, address, and telephone number and be aware of the laboratory's requirements for receiving samples.

In addition, samplers should be aware of the sample holding times, shipping company's hours of operation, shipping schedule, and pick-up and drop-off requirements to avoid delays in analytical testing.

Priority Overnight Delivery

Priority overnight delivery is typically the best method for shipment. Delays caused by longer shipment times may cause the sample temperature to rise above the acceptable range of 4° C (± 2 ° C) and technical holding time may expire, which in turn may compromise sample integrity and require recollection of samples. If sample delivery procedures are to be modified for particular contract- or laboratory-specific requirements, the procedures should be clearly described in site-specific plans such as work plans, FSPs, or QAPPs.

Saturday Delivery

If planning to ship samples for Saturday delivery, the laboratory must be contacted in advance to confirm it will accept deliveries on Saturdays or arrange for them to be accepted. In addition, samplers should ensure the laboratory has been notified in advance of the pending shipment and notify any additional parties as required.

2.4 HEALTH AND SAFETY CONSIDERATIONS

In addition to the procedures outlined in this SOP, all field staff must be aware of and follow the health and safety practices that result from the Activity Hazard Analyses (AHA) for the project. The AHAs include critical safety procedures, required controls, and minimum personal protective equipment necessary to address potential hazards. The hazards specific to project tasks must be identified and controlled to the extent practicable and communicated to all project personnel via the approved, project-specific health and safety plan (HASP).

3.0 POTENTIAL PROBLEMS

The following potential problems may occur during sample shipment:

- Leaking package. If a package leaks (either from broken sample containers or melting ice), the carrier may open the package and return the package. Special care should be taken during sample packaging to minimize potential leaks.

- Improper labeling and marking of package. If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment. A good practice is to have labels, forms, and container markings double checked by a member of the field team.

- Bulk samples and air samples delivered to the analytical laboratory in the same container. If samples are combined in this way, they will be rejected. Always ship bulk samples in separate containers from air samples.

- Issues in packing asbestos samples. When asbestos samples are shipped, avoid using expanded polystyrene because of its static charge potential. Also avoid using particle-based packaging materials with asbestos samples because of possible contamination.

- Improper, misspelled, or missing information on the shipper's declaration. The carrier will most likely notice these errors as well and return the package to the shipper. A good practice is to have another field team member double check this information.

- Missed drop off time or wrong location. Missing the drop off time or having the wrong location identified for drop off will delay delivery to the laboratory and may cause technical holding times to expire. Establish the time requirements in advance of completing the field effort and be sure and provide some contingency time for potential delays such as traffic or checking and redoing paperwork.

- Incorrectly packaging samples for analysis at multiple laboratories. For example, inorganic samples may be shipped to one laboratory for analysis, while organic samples may need to be shipped to another laboratory. All field staff should be aware which samples are to be shipped to which laboratory when they package samples for multiple types of analysis.

- Holidays or weather-related delays. Be aware of holidays and weather forecasts that could cause delays in delivery. Delays caused by longer shipping times may cause technical holding times to expire, which in turn may compromise sample integrity or require recollection of samples.

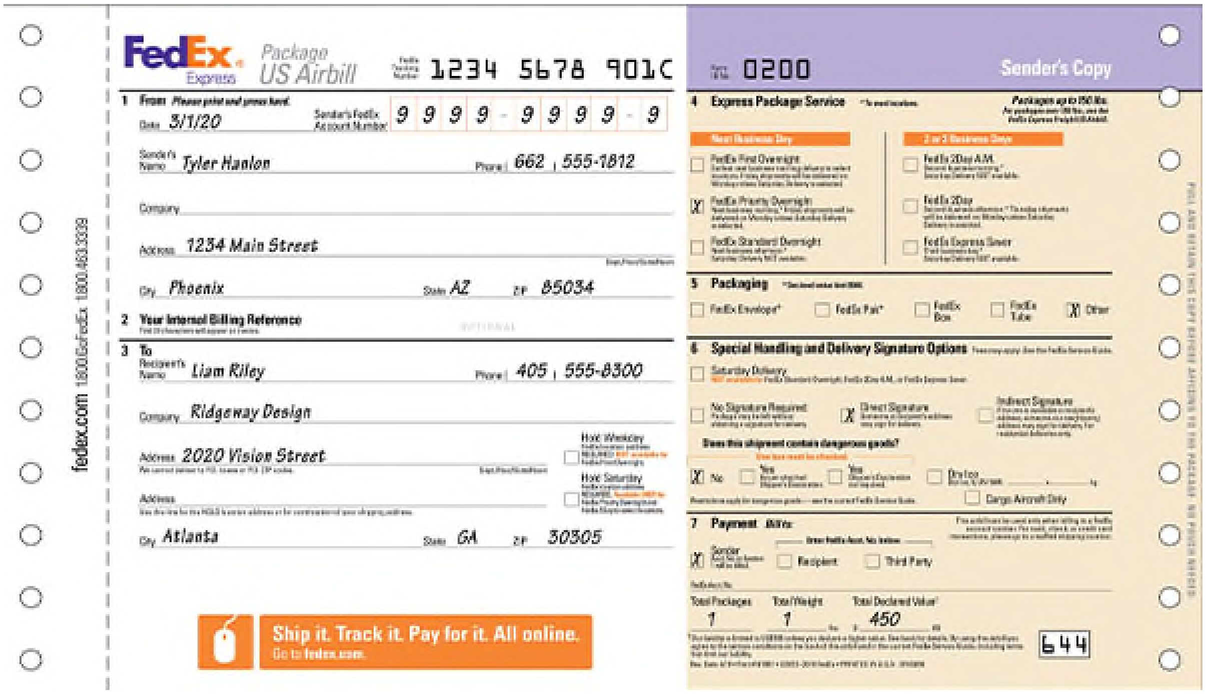
- Not noting field variances in field logbook. Field variances should be noted in the field logbook and the project manager notified. Common field variances include:

    - Less sample volume collected than planned. Notify appropriate staff and the laboratory to ensure there is an adequate amount for analysis.

    - Sample collected into incorrect jar because of broken or missing bottle-ware. Notify appropriate laboratory staff to ensure there is no confusion regarding the analysis of the sample.

FIGURE 1

EXAMPLE OF A FEDEX US AIRBILL FOR LOW-LEVEL ENVIRONMENTAL SAMPLES



Filling Out the FedEx US Airbill

- The sender *must complete* the following fields on the pre-printed airbill:
  - Section 1: Date
  - Section 1: Sender's FedEx Account Number (available from your office administrator)
  - Section 1: Sender's Name, Company, Address, and Phone Number
  - Section 2: Internal Billing Reference (Project Number) (this field may not be present on newer airbills)
  - Section 3: Recipient's Name, Company, Address, and Phone Number
  - Section 4: Express Package or Freight Services (Priority Overnight)
  - Section 5: Packaging (usually "Other," your own packaging)
  - Section 6: Special Handling (Saturday delivery if prearranged with receiving laboratory; "No" dangerous goods contained in shipment)
  - Section 7: Payment ("Bill to Sender")
  - Section 7: Total Number of Packages
  - Section 7: Total Weight (completed by FedEx employee)
  - Section 8: Delivery Signature Options ("No Signature Required")

Completing a Sample Chain-of-Custody Form (See Also Section 2.2 on SCRIBE for Forms)

After samples have been collected, they will be maintained under chain-of-custody procedures. These procedures are used to document the transfer of custody of the samples from the field to the designated analytical laboratory. The same chain-of-custody procedures will be used for the transfer of samples from one laboratory to another, if required.

The field sampling personnel will complete a Chain-of-Custody and Request for Analysis (CC/RA) form for each separate container of samples to be shipped or delivered to the laboratory for chemical or physical (geotechnical) analysis. These forms are often triplicate, carbonless forms. Care should be taken when completing the form that all copies are legible—PRESS FIRMLY WHEN WRITING. Information on the form will include:

1. Project identification (ID) (for example, contract and task order number);
2. Project Contract Task Order (CTO) number;
3. Laboratory Project Order (PO) number;
4. Tetra Tech Technical Contact;
5. Tetra Tech Project Manager;
6. Laboratory name;
7. Field sampler names;
8. Field sampler signature;
9. Sample ID;
10. Date and time of sampling;
11. Sample matrix type;
12. Sample preservation method; note “NONE” if no preservatives;
13. Number and types of containers per sample;
14. Sample hazards (if any);
15. Requested analysis;
16. Requested sample turnaround time or any special remarks (for example, possible presence of free product or high screening concentrations);
17. Page __ of __;
18. Method of shipment;
19. Carrier/waybill number (if any);
20. Signature, name, and company of the person relinquishing the samples and the person receiving the samples when custody is transferred;

21. Date and time of sample custody transfer;

22. Condition of samples when they are received by the laboratory.

The sample collector will cross out any blank space on the CC/RA form below the last sample number listed on the part of the form where samples are listed.

The sampling personnel whose signature appears on the CC/RA form is responsible for the custody of a sample from time the sample is collected until the custody of the sample is transferred to a designated laboratory, a courier, or to another Tetra Tech employee for transporting a sample to the designated laboratory. A sample is considered to be in custody when the custodian: (1) has direct possession of it; (2) has plain view of it; or (3) has securely locked it in a restricted access area.

Custody is transferred when both parties to the transfer complete the portion of the CC/RA form under “Relinquished by” and “Received by” or a sample is left at a FedEx facility pending shipment. Signatures, printed names, company names, and date and time of custody transfer are required. When custody is transferred, the Tetra Tech sampling personnel who relinquished the samples will retain the third sheet (pink copy) of the CC/RA form. When the samples are shipped by a common carrier, a Bill of Lading supplied by the carrier will be used to document the sample custody, and its identification number will be entered on the CC/RA form. Receipts of Bills of Lading will be retained as part of the permanent documentation in the Tetra Tech project file.

FIGURE 2

EXAMPLE OF A CHAIN-OF-CUSTODY FORM (WHITE COPY)

Tetra Tech EM Inc.
Oakland Office
1999 Harrison Street, Suite 500
Oakland, CA 94612
510.302.6300 Phone
510.433.0830 Fax

Chain of Custody Record No. 9814

13G175

Page 1 of 1

	Lab PO#: 13OAK27	Lab: EMAX
Project name: Concord PARNI	TtEMI technical contact: Sara Woolley	Field samplers: Sandy Jack, Rebecca Johnson
Project (CTO) number: 1036R59029	TtEMI project manager: Steve Dellthomme	Field samplers' signatures: Rebecca [signature]

Preservative Added: NONE (SVOA), NONE (Metals), NONE (TPH Extractables)

	Sample ID	Point ID/Depth	Date	Time	Matrix	MS / MSD	40 ml VOA	1 liter Amber	500 ml Poly	Sleeve	Glass Jar 8oz	250 ml Poly	Encore	VOA	SVOA	Pest	Metals	TPH Purgeables	TPH Extractables	PCB
1	029SRESSØ1		7/22/13	1240	Soil						2				X		X		X	X
2	029SRESSØ2		7/22/13	1245							2				X		X		X	X
3	029C3DSSØ1		7/24/13	1208							1				X		X		X	
4	029C3DSSØ2			1215							1				X		X		X	
5	029C3DSSØ3			1230							1				X		X		X	
6	029C3DSSØ4			1245							1				X		X		X	

	Name (print)	Company Name	Date	Time
Relinquished by: Rebecca [signature]	Rebecca Johnson	TtEMI	7/26/13	1630
Received by: Cecilia Chavez [signature]	Cecilia Chavez	EMAX	7/30/13	09:30
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

Turnaround time/remarks: Standard TAT Temp – 2.0°C

Prioritize: SVOCs, TPH-e on 029C3DSS01 → Ø4 then metals

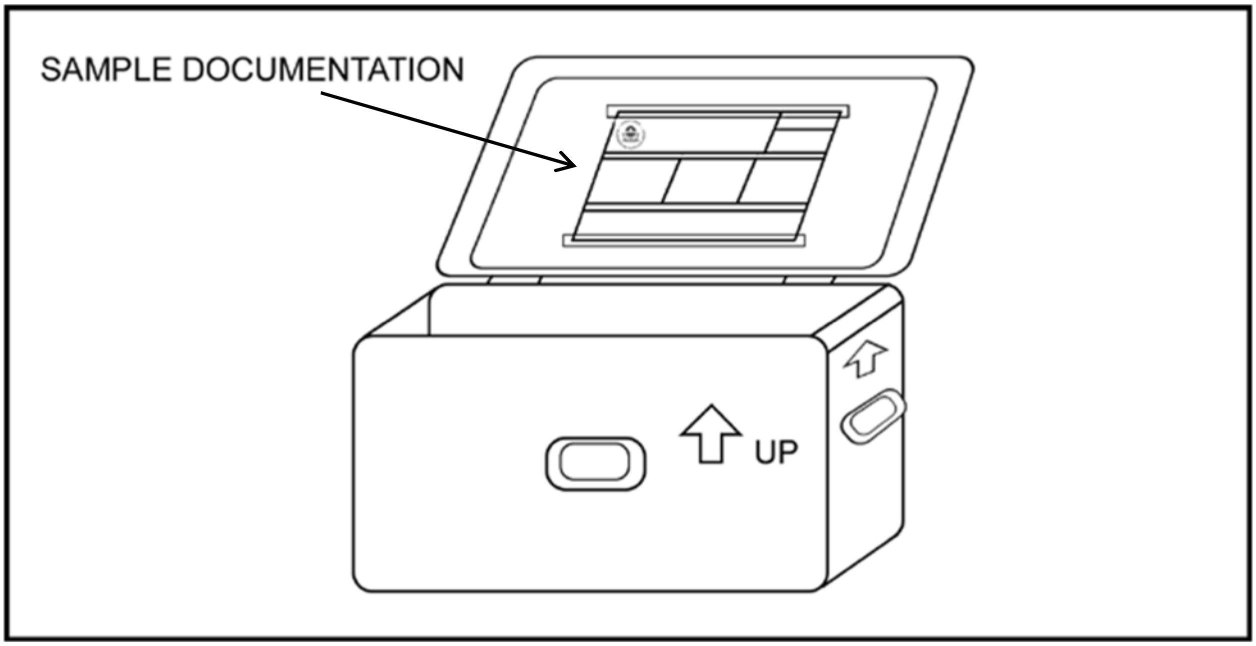
Fed Ex #: 8612 4667 7215

10002

WHITE-Laboratory Copy YELLOW-Sample Tracker PINK-File Copy

FIGURE 3

EXAMPLE OF A SAMPLE COOLER WITH ATTACHED DOCUMENTATION

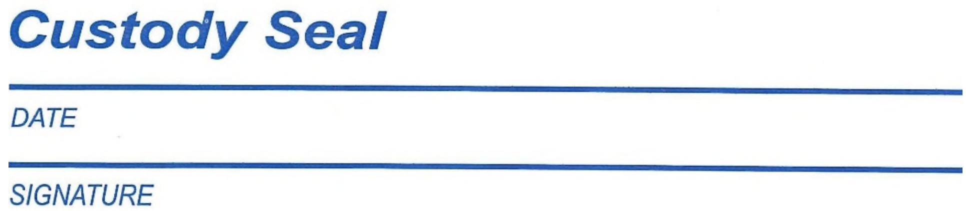


Source: U.S. Environmental Protection Agency. 2014.

Place the necessary paperwork (chain-of-custody form, cooler return instructions, and associated paperwork) in the shipping cooler or acceptable container. All paperwork must be placed in a plastic bag or pouch and then secured to the underside of the shipping container lid.

FIGURE 4

EXAMPLE OF A CUSTODY SEAL

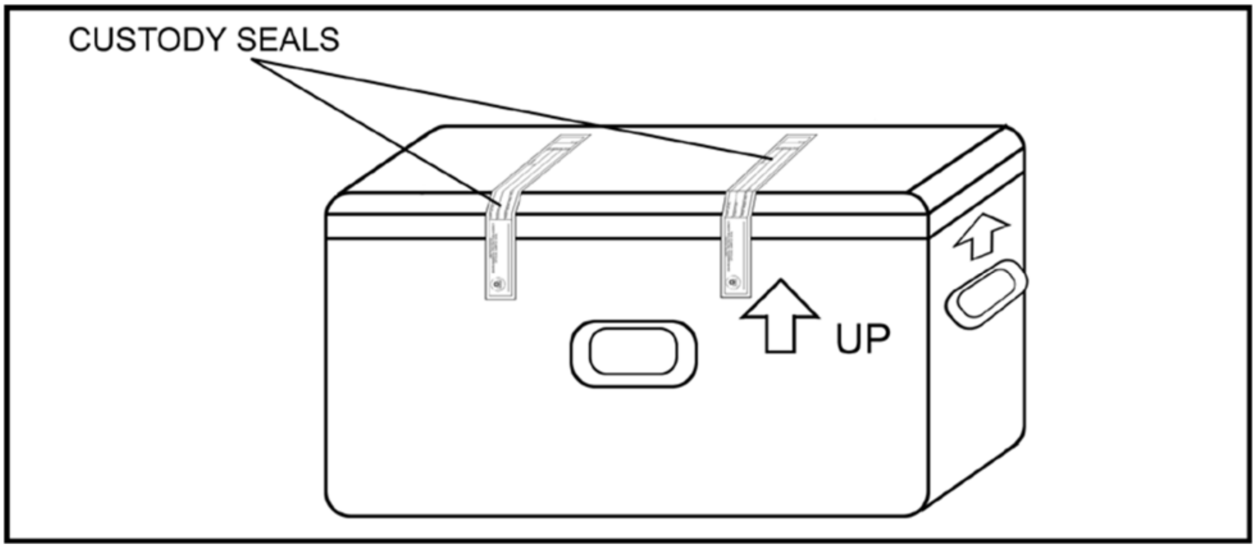

Custody Seal

DATE

SIGNATURE

FIGURE 5

EXAMPLE OF SHIPPING COOLER WITH CUSTODY SEALS



Source: U.S. Environmental Protection Agency. 2014.

Please note that the two seals typically are affixed to opposite sides of the cooler and offset from each other, although the offset is not depicted on the EPA figure above.

SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

RECORDING NOTES IN FIELD LOGBOOKS

SOP NO. 024

REVISION NO. 4

Last Reviewed: December 2022

Quality Assurance Approved

December 2022

Date

1.0 BACKGROUND

Complete and accurate field documentation is critical to a successful project and the field logbook is an important tool to support field documentation needs. The field logbook should include detailed records of all field activities, document interviews with people, and record observations of conditions at a site. Entries should be described in a level of detail to allow personnel to reconstruct, after the fact, activities and events that occurred during their field assignments. Furthermore, entries should be limited to facts. Avoid speculation related to field events and do not record hearsay or unfounded information that may be presented by other parties during field activities. For example, do not record theories regarding the presence or absence of contamination when you are collecting field screening data or speculation regarding the reasons for a property owner's refusal to grant access for sampling.

Field logbooks are considered accountable documents in enforcement proceedings and may be subject to review. Therefore, the entries in the logbook must be accurate and detailed but should not contain speculative information that could conflict with information presented in subsequent project deliverables and correspondence. Also be aware that the field logbooks for a site may be a primary source of information for depositions and other legal proceedings that may occur months or years after field work is complete and long after our memories have faded. The accuracy, neatness, and completeness of field logbooks are essential for recreating a meaningful account of events.

Field notes may also be recorded digitally, using a variety of software programs. The requirements and use of digital recording programs is not addressed in this standard operating procedure (SOP) because many items are unique to the selected software system. However, many of the principles discussed in this SOP will apply to the digital recording of field notes.

1.1 PURPOSE

The purpose of this SOP is to provide guidance to ensure that field logbook documentation collected during field activities meets all requirements for its later use. Among other things, field logbooks may be used for:

- Identifying, locating, labeling, and tracking samples
- Recording site activities and the whereabouts of field personnel throughout the day
- Documenting any deviations from the project approach, work plans, quality assurance project plans, health and safety plans, sampling plans, and any changes in project personnel
- Recording arrival and departure times for field personnel each morning and evening and weather conditions each day

- Describing photographs taken during the project.

In addition, the data recorded in the field logbook may later assist in the interpretation of analytical results. A complete and accurate logbook also aids in maintaining quality control, because it can verify adherence to project scope and requirements.

1.2 SCOPE

This SOP establishes the general requirements and procedures for documenting site activities in the field logbook.

1.3 DEFINITIONS

None.

1.4 REFERENCES

Compton, R.R. 1985. *Geology in the Field*. John Wiley and Sons. New York, NY.

1.5 REQUIREMENTS AND RESOURCES

The following items are required for field notation:

- Bound (sewn) notebooks
- Ballpoint pens or Sharpies with permanent waterproof ink
- 6-inch ruler (optional)

Field logbooks should be bound (sewn) with water-resistant and acid-proof covers, and each page should have preprinted lines or grids and numbered pages. They should be approximately $7^1/_2$ by $4^1/_2$ inches or $8^1/_2$ by 11 inches in size. Loose-leaf sheets are not acceptable for use as a field logbook, although logs and field forms used to record field measurements and data are acceptable as loose-leaf sheets maintained in a three-ring binder with numbered pages, as a supplement to the logbook. If notes are written on loose paper, they must be transcribed as soon as possible into a bound field logbook by the same person who recorded the notes originally.

Ideally, distribution of logbooks should be controlled by a designated person in each office. This person assigns a document control number to each logbook and records the assignment of each logbook distributed (name of person, date distributed, and project number). The purpose of this procedure is to ensure the integrity of the logbook before its use in the field, and to document each logbook assigned to a project. In the event that more than one logbook is assigned to a project, this process will ensure that all logbooks are accounted for at project closeout.

2.0 PROCEDURES

The following subsections provide general guidelines and formatting requirements for field logbooks, and detailed procedures for completing field logbooks.

2.1 GENERAL GUIDELINES

- A separate field logbook must be maintained for each project. If a site consists of multiple subsites (or operable units), designate a separate field logbook for each subsite. Similarly, if multiple activities are occurring simultaneously requiring more than one task leader (for example, well installation, private well sampling, or geophysical survey), each task leader should maintain a separate field logbook to ensure that each activity is documented in sufficient detail.

- At larger sites, a general field log may be kept at the site trailer or designated field office to track site visitors, document daily safety meetings, and record overall site issues or occurrences.

- Data from multiple subsites may be entered into one logbook that contains only one type of information for special tasks, such as periodic well water-level measurements.

- All logbooks must be bound and contain consecutively numbered pages. If the pages are not pre-numbered, the sequential page number should be written at the top of each page.

- No pages can be removed from the logbook for any purpose.

- All information must be entered using permanent, waterproof ink, either a traditional ballpoint pen or a permanent marker. Do not use pens with water-based ink (typically identified as rollerball or gel ink pens) because the ink may wash out if the paper gets wet. Pencils are not permissible for field notes because information can be erased. The entries should be written dark enough so that the logbook can be easily photocopied.

- Be sure that all entries are legible. Use print rather than cursive writing and keep the logbook pages free of dirt and moisture to the extent possible.

- Set apart critical information such as sample numbers by circling or drawing a box around the critical data.

- Do not enter information in the logbook that is not related to the project. The language used in the logbook should be factual and objective. Avoid speculation that could conflict with information presented in subsequent project deliverables and correspondence (see Section 1.0 above).

- Use military time, unless otherwise specified by the client. If a logbook entry is not related to a specific event, set it aside with the identification as a “NOTE.”

- Include site sketches, as appropriate.

- Begin a new page for each day’s notes.

- Include the date, project number, and location (if the project has multiple locations) at the top of each page.
- At the end of a day, draw a single diagonal line through any unused lines on the page, and sign at the bottom of the page. Note and implement any client-specific requirements (for example, some clients require each logbook page to be signed).
- Write notes on every line of the logbook. Do not skip any pages or parts of pages unless a day's activity ends in the middle of a page.
- If a line is left blank for some reason, cross it out (with a single line) and initial to prevent unauthorized entries.
- Cross out (with a single line) and initial any edits to the logbook entries. Note and implement any client-specific requirements (for example, some clients also require that edits be dated). Edits should only be made if the initial entry is illegible or erroneous. Do not make corrections for grammar or style.

2.2 LOGBOOK FORMAT

The layout and organization of each field logbook should be consistent and generally follow the format guidelines presented below. Some clients or contracts may have specific formatting guidelines that differ somewhat from this SOP; review client requirements at the start of the project to help ensure any client-specific guidelines are integrated.

2.2.1 Logbook Cover

Spaces are usually provided on the inside front cover (or the opening page in some logbooks) for the company name, address, contact names, and telephone numbers. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page. Information to be included on the inside front cover or first page includes:

- Logbook document control number (assigned by issuer)
- "Book # of #" (determined by the project manager if there is more than one logbook for the project)
- Contract and task order numbers
- Name of the site and site location (city and state)
- Name of subsite (or operable unit), if applicable
- Type of activity, if the logbook is for a specific activity, such as well installation or indoor air sampling
- Beginning and ending dates of activities entered into the logbook (that is, dates of the activities performed or overseen on site)

2.2.2 Inside Cover or First Page

Spaces are usually provided on the inside front cover (or the opening page in some logbooks) for the company name, address, contact names, and telephone numbers. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page. Information to be included on the inside front cover or first page includes:

- Tetra Tech project manager and site manager names and telephone numbers
- Tetra Tech office address
- Client contact and telephone number
- Site safety officer and telephone number
- Emergency contact telephone number (911, if applicable, or nearest hospital)
- Subcontractor contacts and telephone numbers
- Site property owner or property manager contact information

Note—some clients prohibit the inclusion of personally identifiable information such as personal mobile telephone numbers on official project records.

2.3 ENTERING INFORMATION IN THE LOGBOOK

The following lists provide guidance on the types of information to be included in a typical field logbook. This guidance is general and is not intended to be all-inclusive. Certain projects or clients may specify logbook requirements that are beyond the elements presented in this SOP; as appropriate, any client- or program-specific guidance regarding logbook notation requirements can be referenced in the logbook.

2.3.1 General Daily Entries

- Document what time field personnel depart the Tetra Tech office and arrive at the hotel or site. If permitted by the client to charge travel time for site work, document what time personnel leave and arrive at the hotel each day. (This information may be needed at remote sites where hotel accommodations are not near the site.)
- Indicate when all subcontractors arrive and depart the site.
- Note weather conditions at the time of arrival on site and any changes to the weather that might affect completion of project tasks during the day.
- Include the date and project number at the top of each page.
- Document that a site safety meeting was held and include the basic contents of the meeting.

- List the level of personal protection to be used for health and safety.
- Summarize the day's planned activities.
- Summarize which activities each field team member will be doing.

2.3.2 Field Activity Entries

- Refer to field data collection forms for details about field data collection activities (for example time, date, depth of samples, and field measurements). If separate field sampling sheets are not used, see Section 2.3.3 regarding logbook entries for sampling activities.
- Refer to well purge forms, well construction logs, and other activity-specific forms as applicable rather than including this type of information in the field logbook. These other forms allow the information to be more accessible at a later date.
- List any air monitoring instrumentation used, with readings and locations.
- Refer to instrument field logs for equipment calibration information.
- Summarize pertinent conversations with site visitors (agency representatives, property owners, client contacts, and local citizens).
- Summarize any problems or deviations from the quality assurance project plan (QAPP) or field sampling plan.
- Document the activities and whereabouts of each team member. (As indicated in Section 2.1, multiple logbooks may be required to ensure sufficient detail for contemporaneous activities).
- Indicate when utility clearances are completed, including which companies participated and specific ticket numbers issued by the utility locate vendor.
- Indicate when verbal access to a property is obtained.
- Include names, addresses, and telephone numbers of any pertinent site contacts, property owners, and any other relevant personnel.
- Document when lunch breaks or other work stoppages occur.
- Include approximate scale for all diagrams. If a scale is not available, write "not to scale" on the diagram. Indicate the north direction on all maps and cross-sections, and label features on each diagram.

2.3.3 Sampling Activity Entries

The following information should typically be on a sample collection log and referenced in the logbook. If the project does not use sample sheets as a result of project-specific requirements, this information should be included in the logbook.

- Location description

- Names of samplers
- Collection time
- Designation of sample as a grab or composite sample
- Identification of blind duplicates or split samples
- Type of sample (water, sediment, soil gas, or other medium)
- Sample number
- On-site measurement data (such as pH, temperature, and specific conductivity)
- Field observations (odors, colors, weather)
- Preliminary sample description
- Type of preservative used
- Instrument readings, if applicable

2.3.4 Closing Daily Entries

- Describe decontamination procedures (personnel and equipment).
- Describe handling and disposition of any investigation-derived wastes.
- Summarize which planned activities were completed and which ones were not.
- Note the times that personnel depart the site for the day.
- Summarize any activities conducted after departing the site (paperwork, sample packaging, etc.). This may be required to document billable time incurred after field activities were completed for the day.

2.3.5 Photographic Log Entries

- Before using a digital camera, ensure that the system date and time are correct. Verify whether the timestamp is being recorded on the image, if required.
- Indicate in the text that photographs were taken and the location where the photographs can be found (for example, in the project file) and identify the photographer.
- Begin a new photolog page for each new field day.
- Record the time of photograph so that the image can be generally identified when reviewing the digital files.
- Note the direction in which the photograph was taken, along with any relevant details that might not be understood when looking at the photograph.
- In the event that a film camera is used, the sequential number of the image should also be recorded, and the time from the logbook will be the recorded time for the photograph.

2.4 LOGBOOK STORAGE

Custody of logbooks must be maintained at all times. During field activities, field personnel must keep the logbooks in a secure place (locked car, trailer, or field office) when the logbook is not in personal possession. When the field work is over, the logbook should be included in the project file, which should be in a secured file cabinet; in addition, if directed by the project manager, scan logbook pages for electronic file management upon returning to the office. The logbook may be referenced in preparing subsequent reports and scanned logbook pages may be included as an appendix to a report. However, it is advisable to obtain direction directly from the client before including the logbook as a report appendix, because its inclusion may not be appropriate in all cases.

2.5 HEALTH AND SAFETY CONSIDERATIONS

In addition to the procedures outlined in this SOP, all field staff must be aware of, and follow, the health and safety practices that result from the Activity Hazard Analyses (AHA) for a project. The AHAs include critical safety procedures, required controls, and minimum personal protective equipment necessary to address potential hazards. The hazards specific to project tasks must be identified and controlled to the extent practicable and communicated to all project personnel via the approved, project-specific health and safety plan. If health and safety conditions warrant a change to sampling approaches or locations, this should be documented in the field logbook.

SOP APPROVAL FORM

TETRA TECH, INC.

EMI OPERATING UNIT

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

CALIBRATION OF AIR SAMPLING PUMP

SOP NO. 064

REVISION NO. 1

Last Reviewed: August 2020

(signature)	*August 12, 2020*
Quality Assurance Approved	Date

1.0 BACKGROUND

Several instruments are available to calibrate low air flow rate. This standard operating procedure (SOP) will assume the use of a MesaLabs Bios DryCal Defender 510 or 520 for calibration of high volume (flow rate greater than 5 liters per minute (L/min)) and low volume (flow rate of 5 L/min or lower). This SOP also assumes the use of a low volume air sampling pump similar to the Sensidyne GilAir Plus, a digital air sampling pump, and the use of a high-volume air sampling pump similar to the SKC QuickTake® 30. The air calibration procedure discussed in this SOP will work for analog air sampling pumps as well, such as the Sensidyne GilAir 5 or Sensidyne Aircon 2. A DryCal calibrator is used to calibrate sample collecting devices, which includes an air sampling pump with attached media, such as filters, impingers, sampling tubes, and color detector tubes.

1.1 PURPOSE

This SOP establishes the requirements and procedures for calibrating a digital air sampling pump using a MesaLabs Bios DryCal Defender.

1.2 SCOPE

This SOP provides instruction on the calibration of a digital air sampling pump and sample media using a BIOS DryCal Defender Calibrator.

1.3 REFERENCES

Bios International Corporation. 2007. “Defender 500 Series User Manual” Form #MK01-25, Rev B. Bios, 2007.

Sensidyne, LP. 2011. “GilAir Plus Operation Manual.” Form #360-0132-01, Rev D. Sensidyne.

SKC Inc. 2010. “QuickTake 30 Sample Pump Operating Instructions.” Form #40079, Rev 1910. SKC Inc.

U.S. Environmental Protection Agency (EPA). 2020. “Operation of DryCal Defender Series Primary Flow Calibrator.” Environmental Response Team. EPA-PROC-2130-19. January.

1.4 REQUIREMENTS AND RESOURCES

To calibrate an air sampling pump, the following equipment is needed:

- Air sampling pump (GilAir Plus or QuickTake 30, or similar digital pump)
- DryCal calibrator (Bios Defender 500 series or similar)

- Sample media (mixed cellulose ester (MCE) membrane filter, polyurethane foam (PUF) tube, phase contrast microscopy (PCM) filter, etc.)
- Logbook or field data forms (can be electronic)
- Sample labels

The DryCal defender must be calibrated annually by an accredited vender to ensure accuracy and function.

2.0 PROCEDURE

The following procedure is used to calibrate a sampling pump with a Bios DryCal Defender 520 or 530. If only using a low volume air sampling pump, use a "medium" (50-5,000 milliliters per minute (mL/min)) model of the 520 or 530. If using only a high volume, or a high volume and a low volume air sampling pump, use a "high" (300-30,000 mL/min) model.

Before calibration can occur, establish a flow rate for the air sampling pump. This will require a review of the method, a discussion with the analytical laboratory, and a review of the established reporting limits. Check the calibration at the beginning and end of the sampling event to establish an average flow rate for the sampling event. Calibrate equipment in the field as close to the start of the sample time as possible in order to obtain an accurate representation of field conditions during the time of sampling.

The procedure for calibrating an air sampling pump is as follows:

1. Attach the tubing to the suction fitting (Figure 1).
2. Attach the sample media, additional tubing, and then the sample pump (Figure 2). If sampling with multiple pumps and media, calibrate each pump with the media that will be attached to that pump. Use flexible tubing to attach the sample media and pump to the DryCal calibrator. Ensure no kinks are present and use the shortest length of tubing as reasonable.
3. Turn on the DryCal calibrator. To power on, press the On/Off button in the lower right corner of the control panel for one second.
4. Navigate through the Defender menu screen using the four arrows on the control panel. Select your desired menu option using enter in the center of the four arrows. Ensure in "SETUP" that the units are set to your preference and continuous flow is set up to take 10 readings with one second between each reading.
5. Navigate to the "Measure" option on the menu screen. Select continuous and press enter.
6. Turn the sampling pump on. The continuous measurement on the DryCal calibrator should start automatically. You will see a reading count at the bottom of the display. To receive the average

flow rate, pause at the 10th reading by disconnecting the pump or hitting the enter button. This reading will be the flow rate you record for that pump.

7. Record the calibration information in a logbook or on electronic form where minute and total flow volume calculations will be calculated electronically. An example of an electronic form is shown in Figure 3. Record the following information in the form:

    - Flow rate (start and end)
    - Serial number of the pump
    - Pump number
    - Date
    - Sample start and end times
    - Location of sample
    - Analysis

8. At the end of the sampling event, collect the end flow rate and end sample time. Put sample name, date, and end time on the sample label. Enter all information into an air calculation form and calculate total air volume for your samples. This can be done by hand, but it is recommended to use an electronic air calculation form. In order to calculate total air volume, average the start and end flow rates, determine the total minutes the pump was ran for using the start and flow times[1], multiply the average flow rate and total minutes.

Example:

Name	Pump Serial #	Location	Analysis	Start Time	End Time	Total Minutes	Start Flow (L/min)	End Flow (L/min)	Average Flow (L/min)	Total volume (Liters)
Sample 1	0001	East Perimeter	Metals	0702	1503	481	4.12	3.98	4.05	1948.05

Note: [1]Air sample pumps can fault. If the pumps are digital you can get the total run time from the pump. If the pumps are analog, the end time will be the time when the pump fault was observed. It is recommended to check air sampling pumps every hour to minimize time discrepancies.

9. Fill out the chain of custody with the information shown in the above example. Double check ALL calculations, be especially cautious that total minutes were calculated correctly. Double check the chain matches your total volume calculations.

FIGURE 1

BIOS DRYCAL DEFENDER LAYOUT

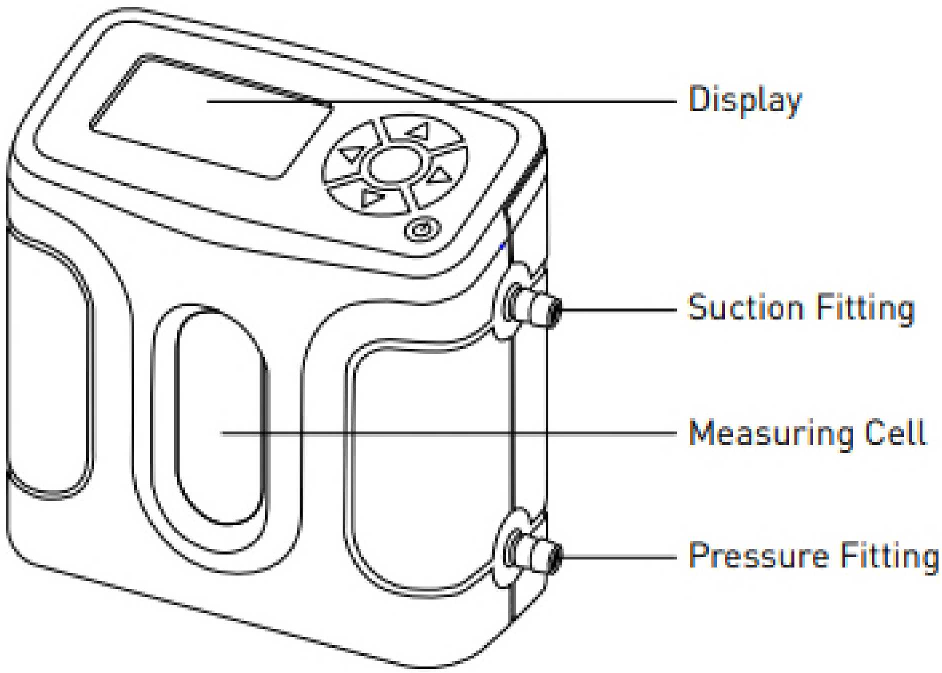


FIGURE 2

CALIBRATION SET UP

FIGURE 3

ELECTRONIC FORM EXAMPLE

Air Sampling Form

Crawford Demolition ER

TOLIN:
Site: Crawford
Method: NIOSH 7400 and NIOSH 7402
Air Sampling Technician: C.Renner
Date: 6/1/2020
Primary Calibration: Bios DryCal D.C. Lite

Pump ID	Sample I.D.	Start Time	Stop Time	Total Min.	Start Flow Rate (L/min)	Stop Flow Rate (L/min)	Corrected Flow Rate	Total Volume (liters)	Pump Fault	Location
QT080	CPP-SP-200601	7:15	12:00	284.00	9.98	9.98	9.980	2834.32		South Asbestos
GA208	CPP-SP-200601	7:15	12:00	285.00	4.02	3.82	3.920	1117.20		South Metals
GA116	CPP-SP-200601	7:15	12:00	285.00	5.01	5.06	5.035	1434.98		South PCB

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The policies and procedures established in this document are intended solely for the guidance of OLEM employees of the U.S. Environmental Protection Agency (EPA). They are not intended and cannot be relied upon to create any rights, substantive or procedural, enforceable by any party in litigation with the United States. EPA reserves the right to act at variance with these policies and procedures, and to change them at any time without public notice. EPA strongly encourages all readers to verify the validity of the information contained in this document by consulting the most recent Code of Federal Regulations (CFR) and updated guidance documents.

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1.0 SCOPE AND APPLICATION

Asbestos are naturally occurring fibrous minerals including: chrysotile, crocidolite, amosite, tremolite, actinolite, anthophylite, and any of these minerals that have been chemically treated and/or altered. The precise chemical formulation of each species will vary with the location from which it was mined. Asbestos has been used in many commercial products, including building materials such as flooring tiles and sheet goods, paints and coatings, insulation, and roofing asphalts. These products and others may be found at hazardous waste sites, hanging on overhead pipes, contained in drums, abandoned in piles, or as part of a structure are also known as asbestos containing material (ACM). Naturally occurring asbestos (NOA) in multiple forms can also be found. NOA associated with vermiculite mining and operations, and asbestos tailing piles from vermiculite mining operations can be a source of ambient asbestos fibers.

Asbestos is a known carcinogen, and air sampling is necessary to assess the potential for airborne exposure as part of a human health risk assessment. This standard operating procedure (SOP) provides procedures for asbestos air sampling based on drawing a known volume of air through a mixed cellulose ester (MCE) filter, which is then sent to a laboratory for analysis. One of the following four analytical methods is typically used for determining asbestos in air by ERT. These methods consist of: (1) National Institute for Occupational Safety and Health (NIOSH) Method 7400 for Phase Contrast Microscopy (PCM); (2) NIOSH Method 7402, Asbestos by TEM; (3) ISO 10312, Ambient Air - Determination of Asbestos Fibers – Direct Transfer Transmission Electron Microscopy (TEM) Method; and (4) ISO 13794 Ambient Air - Determination of Asbestos Fibres - Indirect-Transfer Transmission Electron Microscopy Method. Each method has specific sampling and analytical requirements (i.e. sample volume and flow rate) for determining asbestos in air.

The United States Environmental Protection Agency (U.S. EPA)/Environmental Response Team (ERT) typically follows procedures outlined in the TEM methods for determining mineralogical types of asbestos in air and for distinguishing asbestos from non-asbestos minerals. The PCM method is primarily used as a screening tool since it is less costly than TEM. TEM is used to distinguish asbestos fibers from non-asbestos fibers and characterize asbestos mineral species. The PCM method can be used to estimate asbestos concentrations, but the PCM method cannot distinguish asbestos from non-asbestos fibers. The TEM method, therefore, may be necessary to confirm analytical results. For example, if an action level for the presence of fibers has been set and PCM analysis indicates that the action level has been exceeded, TEM analysis can be used to quantify and identify asbestos structures through examination of their morphology, crystalline structures (through electron diffraction), and elemental composition (through energy dispersive X-ray analysis). In this instance, samples can be collected for both analyses on the same filter or in side by side sampling trains. The direct preparation method is designed specifically to provide results suitable for supporting human health risk assessments at Superfund sites, and the direct and indirect preparation methods are applicable to a wide range of ambient air situations at hazardous waste sites. The PCM and TEM NIOSH analytical methods require lower sample volumes than the ISO methods; however, both NIOSH methods can be adapted for ambient air sampling if the sampling volume is increased appropriately.

Regulations pertaining to asbestos have been promulgated by the U.S. EPA and Occupational Safety and Health Administration (OSHA). The U.S. EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) regulates asbestos-containing waste materials. NESHAP establishes management practices and standards for the handling of asbestos and emissions from waste disposal operations under 40 Code of Federal Regulations (CFR) Part 61, Subparts A and M. Comprehensive rules for the asbestos abatement industry were promulgated under 40 CFR 763. State and local regulations regarding asbestos management and assessment practices vary and may be more stringent than federal requirements. The OSHA regulations in

29 CFR 1910.1001 (general industry; formerly designated 29 CFR 1926.58), 29 CFR 1926.1101 (construction industry), and 29 CFR 1915.1001 (shipbuilding industry) specify work practices and safety equipment including respiratory protection and protective clothing when handling asbestos or ACM. The OSHA 8-hour, time-weighted average (TWA) is 0.1 fibers per cubic centimeter (f/cc) of air. This standard pertains to fibers with a length-to-width ratio of 3 to 1 with a fiber length greater than 5 microns (µm). Assessment and monitoring of airborne asbestos is required by OSHA to determine if asbestos is present in the workplace and if the work will generate airborne fibers. In addition, employers may be required to establish an employee training program, medical surveillance program, and install engineering or institutional controls in conjunction with an asbestos assessment or monitoring program.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations, or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form that is attached to the QAPP. These changes must also be documented in the final deliverable.

2.0 METHOD SUMMARY

If possible and prior to sampling, the site should be characterized by identifying on-site and off-site sources of airborne asbestos. The array of proposed sampling locations and the schedule for sample collection are critical to the success of an investigation. In general, sampling strategies to characterize a single point source are fairly straightforward, while multiple point sources and/or area sources increase the complexity of the sampling strategy. Experience, objectives, and site characteristics will dictate the sampling strategy.

During a site investigation, sampling stations should be arranged to support the evaluation of spatial trends in airborne asbestos concentrations, and sampling schedules should be fashioned to establish temporal trends. The sampling strategy typically requires that the concentration of asbestos at the source (worst case), area of concern (downwind), crosswind areas, and background areas (upwind) contributions be quantified. Indoor air asbestos sampling events require a different type of sampling strategy. Consult the site-specific QAPP for all sampling activities. It is critical to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks can be utilized to determine other sources.

Prior to sampling, the site sampling objectives should be identified in the site-specific QAPP to support the selection of the most appropriate analytical method. Additionally, the specific sampling requirements, required equipment and sample preparation, and quality control data quality objectives (DQOs) should be identified in the QAPP prior to sampling. Each analytical method has specific sampling requirements and produce results which may or may not be applicable to a specific sampling effort. Consult with the end line stakeholders, toxicologists and risk assessors in the early stages of project planning in order to determine the best course of action.

The following sampling and analytical protocols may be used for asbestos determination.

- NIOSH 7400 – Determination of Asbestos and Other fibers by Phase Contrast Microscopy.

- ASTM International (ASTM) D7200-12 – Sampling and Counting Airborne Fibers, Including Asbestos Fibers, in Mines and Quarries, by Phase Contrast Microscopy and Transmission Electron Microscopy.

- ASTM D7201-06 (Reapproved 2011) – Sampling and Counting Airborne Fibers, Including Asbestos Fibers in the Workplace, by Phase Contrast Microscopy (with an Option of Transmission Electron Microscopy.

- International Organization for Standardization (ISO) 8672:2014 – Determination of the Number Concentration of Airborne Inorganic Fibres by Phase Contrast Optical Microscopy – Membrane Filter Method.

- NIOSH 7402 – Asbestos by Transmission Electron Microscopy.

- Asbestos Hazard Emergency Response Act (AHERA) – 40 CFR Part 763 Appendix A to Subpart E Interim Transmission Electron Microscopy Analytical Method.

- ISO Method 10312: Ambient Air – Determination of Asbestos Fibres – Direct Transfer Transmission Electron Microscopy Method.

- ISO Method 13794: Ambient Air – Determination of Asbestos Fibres – Indirect Transfer Transmission Electron Microscopy Method.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Sample Preservation

No preservation is required for asbestos samples.

3.2 Sample Handling, Container and Storage Procedures

1. Place a sample label on the cassette that indicates a unique sampling number. Do not put sampling cassettes in shirt or coat pockets as the filter can pick up interfering fibers. The original cassette box can be used to hold the samples.

2. Upon completing the sampling, store the cassettes individually in a manila envelope. Each envelope should be labeled with the sample identification number, location, total sampling time, total volume and sampling date.

3. The wrapped sampling cassettes should be placed upright in a rigid container to ensure that the cassettes are oriented vertically (i.e., the caps for the top and bottom align with the top and bottom of the container). Use enough packing material to prevent jostling or damage. Do not use vermiculite as packing material for samples. If possible, hand deliver the samples to the laboratory.

4. Provide appropriate documentation with samples (i.e., chain of custody, requested analytical methodology, and other information specific to the laboratory analyzing samples).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Flow rates exceeding 16 liters/minute (L/min) that could result in filter destruction due to (a) failure of its physical support under force from the increased pressure drop; (b) leakage of air around the filter mount so that the filter is bypassed, or (c) damage to the asbestos structures due to increased impact velocities.

The filter and it associated back pressure will limit flow rates that are able to be achieved. When utilizing a 0.8-µm filter cassette higher flow rates are achievable than when using a 0.45-µm filter cassette. To the best extent possible do not operate pumps at their maximum capacity. When calibrating a pump, there is a point at which the maximum flow through a filter is achieved before the pump flow adjustment has been maximized. Even though the pump may sound indicates it is still accelerating, the flow will not increase. In this case turn the adjustment back to the point below maximum draw. Higher than acceptable flow rates can damage the filter and pump. Not all pumps are created equally, even those of identical make and manufacturer. Total sampling times will vary based on battery draw.

For high-volume samples, the filter overload should be no higher 25 percent (%). If a high-volume sample is determined to be overloaded and a lower volume collocated sample was collected, the corresponding low-volume sample can be analyzed. For low-volume samples that are greater than 25% overloaded, the laboratory must have the capability of analyzing these samples using ISO Method 13794 (indirect method).

4.1 Filter Preparation Methods

4.1.1 ISO 10312 Direct-Transfer TEM Specimen Preparation Method

Direct-transfer TEM specimen preparation methods have the following interferences:

- This method cannot discriminate between individual fibers of asbestos and elongate fragments (cleavage fragments and acicular particles) from non-asbestos analogues of the same amphibole mineral.

- Complete identification of every chrysotile and/or amphibole fiber is not possible due to instrumental limitations and the nature of some of the fibers. Additionally, complete identification of every amphibole fiber is not practical due to the limitations of both time and cost.

- On rare occasions, some amphibole fibers can visually be misidentified as chrysotile. Particles of other minerals having visual compositions similar to those of some amphiboles could be erroneously classified as amphibole. Use of energy dispersive X-ray analysis (from the method) can eliminate the misidentification.

- The achievable detection limit (DL) is restricted by the particulate density on the filter, which in turn is controlled by the sampled air volume and the total suspended particulate concentration in the atmosphere being sampled.

- The precision of the result is dependent on the uniformity of the deposit of asbestos structures on the sample collection filter.

- Air samples should be collected to ensure that the particulate and fiber loadings are within a specified narrow range. If particulate loading on the filter is too high, it is not possible to prepare satisfactory TEM specimens by a direct-transfer method. In this case, even if satisfactory TEM specimens can be prepared, accurate fiber counting may not be possible.

4.1.2 ISO 13794 Indirect TEM Specimen Preparation Method

Indirect TEM specimen preparation methods have the following interferences:

- The size distribution of asbestos structures is modified.

- There is increased opportunity for fiber loss or introduction of extraneous contamination.

- When sample collection filters are ashed, any fiber contamination in the filter medium is concentrated on the TEM specimen grid.

- There is a possibility of misidentification of fibers for which both the morphologies and the electron diffraction (ED) patterns are reported on the basis of visual observation only. This can be rectified by the use of energy-dispersive x-ray analysis (EDXA) and the observation of the 0.73 nanometer (nm) reflection of chrysotile in the ED pattern.

- Particles of a number of other minerals may have compositions similar to amphiboles. These could be classified as amphibole when the classification criteria does not include zone-axis ED techniques

It can be argued that direct methods yield an under-estimate of the asbestos structure concentration because many of the asbestos fibers present are concealed by other particulate material with which they are associated. Conversely, indirect methods can be considered to yield an over-estimate of the asbestos structure concentration because some types of complex asbestos structures disintegrate during the preparation, resulting in an increase in the numbers of structures counted.

4.2 NIOSH Method for TEM

Other amphibole particles that have aspect ratios greater than 3:1 and elemental compositions similar to the asbestos minerals may interfere with the TEM analysis. Some non-amphibole minerals may give electron diffraction patterns similar to amphiboles. High concentrations of background dust interfere with fiber identification.

4.3 NIOSH Method for PCM

PCM cannot distinguish asbestos from non-asbestos fibers; therefore, all particles meeting the counting criteria are counted as total asbestos fibers. Fibers less than 0.25 µm in length will not be detected by this method. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the DL.

5.0 EQUIPMENT/MATERIALS

5.1 Sampling Pump

The constant flow or critical orifice controlled sampling pump should be capable of a flow rate and pumping time sufficient to collect the desired air sample volume

The low flow personal sampling pumps generally provide a flow rate of 20 cubic centimeters per minute (cc/min) to 4 L/min, and these pumps are usually battery powered

High-flow pumps are utilized when flow rates between 2 L/min to 16 L/min are required. High-flow pumps are generally used for short sampling periods. A stand should be used to hold the filter cassette at the desired height for sampling and the filter cassette shall be isolated from the vibrations of the pump. Given that the proposed sampling locations may be located in remote areas or a significant distance from a stationary alternating current (AC) power source, consideration of how to provide electrical power for the pumps must be considered prior to sampling. High-flow pumps operate preferentially on AC power, but a generator or an external battery supply can be utilized as an alternative source of power. If a generator is used, the generator should be positioned downwind from the sampling stands to avoid cross contamination or interference with the samples being collected. Voltage and amperage should be closely monitored when running more than one high flow pump using the same power source.

5.2 Filter Cassette

The cassettes are purchased with the required filters in position. A shrink cellulose band or adhesive tape is usually applied to the cassette joints to prevent air leakage.

5.2.1 TEM Cassette Requirements

For NIOSH Method 7402, TEM, commercially available 25-millimeter (mm) diameter two-piece cassette with a conductive extension cowl will be used for sample collection. The cassette must be new and not previously used. The cassette will be loaded with a MCE filter with a pore size between 0.45 to 1.2 µm that was supplied from a lot number that was qualified as low background for asbestos determination. The cowls should be constructed of electrically-conducting material to minimize electrostatic effects. The filter will be backed by a 5-µm pore size MCE diffuser and support pad (Figures 1 and 2, Appendix A).

5.2.2 PCM Cassette Requirements

For NIOSH Method 7400, PCM, a 25-mm, 0.45 or 0.8-µm MCE filter cassette (typical pore sizes) with conductive extension cowl will be used for sample collection. The MCE filter will be backed by a support pad (Figures 1 and 2, Appendix A). Some labs are able to perform both the PCM and TEM analyses on the same filter; however, this should be discussed with the laboratory prior to sampling.

ERT typically uses the 0.8-µm MCE filter cassette. Consult with the end line stakeholders, toxicologists and risk assessors in order to determine the best course of action.

5.3 Other Equipment

- Sampling trains
- Manila envelopes (#6 coin size preferred) for cassettes
- Tools - small screwdrivers
- Container (to keep samples upright)
- Generator or electrical outlet (may not be required)
- Extension cords (may not be required)
- Multiple plug outlet (may not be required)
- Sample labels
- Air sampling data sheets
- Chain of custody records
- Scribe

6.0 REAGENTS

Reagents are not required for the collection or preservation of asbestos samples.

7.0 PROCEDURES

7.1 Flow Rates, Air Volumes and Analytical Sensitivity

Occupational Safety and Health Administration (OSHA) method ID-161, *Asbestos in Air,* shows an acceptable flow rate from 0.5 to 5 liters per minute (LPM). National Institute of Occupational Safety and Health (NIOSH) methods 7400, *Asbestos and Other Fibers by PCM* and 7402, *Asbestos by TEM* refer to flow rates ranging from 0.5 to 16 LPM.

These methods were developed for occupational settings where asbestos was expected to be present and would demonstrate the compliance or non-compliance of the OSHA permissible exposure level (PEL) of 0.1 fiber per cubic centimeter.

7.1.1 Occupational Methods

The listed minimum recommended volume for TEM and PCM is 400 L at 0.1 f/cc. The sampling time is adjusted to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for eight hours (480 to 1920 L) is appropriate in non-dusty atmospheres containing 0.1 f/cc. Dusty atmospheres (i.e., areas with the potential for high levels of airborne asbestos) require smaller sample volumes (sometimes significantly less than 400 L) to obtain countable samples.

If a time-integrated sample is required, when collecting samples in dusty environments, collect short, consecutive samples and average the results over the total collection time.

For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres where targeted fiber concentrations are significantly less than 0.1 f/cc, collect a larger sample volume (3,000 to 10,000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If loading is greater than 20-25% of the filter surface covered with particles, the measured fiber concentration may be biased, or the filter may be too overloaded to count.

7.1.2 Risk-based Methods

OSWER Directive 9345.4-05 recommended the development of risk-based, site-specific air action levels to determine if response actions for asbestos in soil/debris should be undertaken. Because inhalation is the exposure pathway of concern for asbestos, an action (or screening) level for asbestos in air is an appropriate metric for site managers in making the determination of whether a response action, no action, or further, more detailed investigation at a given site is warranted. This led to the development of OSWER's Framework for Investigating Asbestos-Contaminated Superfund Sites in 2008, which recommends the use of ISO 10312.

Sampling volumes will be determined, based on the analytical sensitivity required for a particular task. The sensitivity is defined as the structure concentration corresponding to the detection of one structure by ISO 10312. Sensitivities can vary from project to project and within tasks on a project. The desired sensitivity can be met through a combination of volume collected and number of filter grids counted by the microscopist for the TEM by the direct transfer method. Limit of detection is usually defined as 3 times the analytical sensitivity. Before collecting any samples, consult with the end line stakeholders, toxicologists and risk assessors in the early stages of project planning in order to determine the required analytical sensitivity.

The following example, of number of grids to be counted, is a condensed excerpt from the Code of Federal Regulations Chapter 40 Part 763, Subpart E, Appendix A. In this example the number of grids to be counted will reflect an analytical sensitivity of 0.005 structures per cubic centimeter from a 25-millimeter (mm) filter with an effective area of 385 mm^2.

Volume in Liters	Grid Openings
600	23
1200	11
1800	8
2400	6
3000	5
3600	4

Typically, battery-operated (personal) pumps are utilized for sampling at flow rates less than 5 LPM. Battery operated pumps are also capable of collecting samples at flow rates up to 16 LPM. Generally, the higher the flow rate required the heavier the sampling pump. AC operated pumps are also capable of sampling at flow rates up to 16 LPM.

7.2 Calibration Procedures

To determine if a sampling pump is measuring the flow rate or volume of air correctly, it is necessary to calibrate the instrument. Sampling pumps are calibrated before and after each use. Preliminary calibration is conducted using a primary or secondary calibration device such as an electronic calibrator or rotameter with a representative filter cassette installed between the pump and the calibrator. The representative sampling cassette can be reused for calibrating other pumps that will be used for asbestos sampling. A cassette from the same lot used for sampling should also be used for the calibration. A sticker can be affixed to the outside of the extension cowl marked "Calibration Cassette." The calibration cassette cannot be used as a sampling cassette.

Constant flow calibration readings are obtained before and after sampling. If the flow rate changes by more than 5% during the sampling period, the average of the pre- and post-calibration rates will be used to calculate the total sample volume. The sampling pump used will provide a non-fluctuating air-flow through the filter, and the flow rate should be maintained within 10% of the initial volume flow rate throughout the sampling period. The value of these flow-rate measurements will be used to calculate the total air volume sampled. A constant flow or critical orifice controlled pump meets these requirements. If at any time the measurement indicates that the flow-rate has decreased by more than 30%, the sampling may be terminated. It will be determined by the end user of the data if the sample should be analyzed. Flexible tubing is used to connect the filter cassette to the sampling pump. Sampling pumps can be calibrated prior to coming on-site to reduce the amount of time spent performing on-site calibration activities.

7.2.1 Calibrating a Personal Sampling Pump with a Rotameter

1. For ERT rotameters, perform calibrations following directions established in ERT SOP, *Rotameter Calibration*.

2. Set up the calibration train as shown in (Figure 3, Appendix A) using a rotameter, sampling pump, and a representative sampling cassette.

3. To set up the calibration train, attach one end of the Tygon tubing (approximately 2 feet) to the cassette cap air inlet or cover open inlet-end of cowl with rubber

cassette calibration adapter (shown in figure); attach the other end of the tubing to the air outlet (top fitting) on the rotameter. Another piece of tubing is attached from the cassette base air outlet to the inlet of the sampling pump.

4. Ensure that the rotameter is as level as possible when recording sampling flow rates.

5. Turn the sampling pump on.

6. Turn the flow adjust screw (or knob) on the personal sampling pump until the float ball on the rotameter is lined up with the pre-calibrated flow rate value. A sticker on the rotameter should indicate this value. Confirm the flow rate after approximately 10 seconds. Adjust flow rate accordingly.

7. A verification of calibration is generally performed on-site in the clean zone immediately prior to sampling.

7.2.2 Calibrating a Personal Sampling Pump with an Electronic Calibrator

1. Refer to the manufacturer's manual for operational instructions. Ensure that the unit has been calibrated within the past year.

2. Set up the calibration train as shown in (Figure 4, Appendix A) using a sampling pump, electronic calibrator, a representative filter cassette and Tygon tubing. A cassette from the same lot used for sampling should also be used for the calibration.

3. To set up the calibration train remove the air outlet plug of the sampling cassette and attach one end of the Tygon tubing (approximately 2 feet) to the cassette outlet; attach the other end of the tubing to the inlet of the sampling pump. Another piece of tubing is attached from the cassette inlet cap to the inlet of the electronic calibrator or cover open inlet-end of cowl with rubber cassette calibration adapter (shown in figure).

4. Turn the electronic calibrator and sampling pump on.

5. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained. Confirm the flow rate after approximately 10 seconds. Adjust flow rate accordingly.

7.3. Meteorology

It is recommended that an onsite, portable, 3-meter meteorological station be established. If possible, sample after two to three days of dry weather when wind conditions are representative for the climatology of the location based on month and time of day. Historical hourly wind speed and wind direction data should be analyzed before mobilization. Wind speed, wind direction, temperature and station pressure should be recorded and real-time data should be available for review. A nearby representative meteorological station, may be used to acquire the necessary data.

7.4 Ambient Sampling Procedures

7.4.1 Pre-Site Sampling Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling equipment and ensure it is in working order and fully charged (if necessary).

3. Perform a general site survey prior to site entry in accordance with the site-specific Health and Safety Plan.

4. Once on-site, perform calibration of the sampling equipment in the clean zone. The calibration procedures are summarized in Section 7.2.

5. After calibrating the sampling pump, mobilize to the sampling location.

7.4.2 Site Sampling

1. Prior to sampling, assemble the sampling train as illustrated in Figures 5 (Personal Sampling Train for Asbestos) and Figure 6 (High Flow Stationary Sampling Train for Asbestos), Appendix A, by connecting one end of the Tygon tubing to the cassette cap (air inlet); connect the other end of the tubing to the inlet of the sampling pump. The cassette should be positioned downward or at a 45 degree angle.

2. If AC or direct current (DC) electricity is required, turn the power on. If used, a generator should be placed at least 10 feet downwind of the sampling pump.

3. Turn the pump on. Record the following parameters or air sampling worksheets or in a field logbook: date, time, location, sample identification number, pump number, flow rate, and cumulative time.

5. Check the pump at the sampling mid-point if the sampling duration is longer than 4 hours. If generators are used, they may need to be refueled depending on tank size. If a filter darkens in appearance or if loose dust is seen in the filter, a second sample should be started.

6. At the end of the sampling period, orient the cassette up, and turn the pump off.

7. Check the flow rate of each sampling cassette as described in Section 7.2 before removing from the pump. Note that increased dust/fiber loading may have altered

the flow rate.

8. Record the post flow rate, cumulative time or pump run sample end time and date.

9. Remove the tubing from the sampling cassette. Still holding the cassette upright, replace the cassette cap and the inlet and outlet plugs.

7.4.3. Post Site Sampling

Follow handling procedures described in Section 3.2.

7.5 Indoor Sampling Procedures

The inlet of the sampling pump should be placed at a (breathing) height four to five feet above floor level and away from obstructions that may affect air flow. For example, the pump can be placed on a table or counter. Sensitive receptor areas should be given priority. Refer to the site-specific QAPP for a summary of indoor sampling locations and rationale for selection. The optimum positions for collection of air samples should be determined after a complete survey of the unit is conducted. A sufficient number of samples should be collected in areas where known asbestos materials are present to characterize the unit. Control samples should be collected in adjacent areas where no airborne asbestos would be expected (i.e, near intakes for the air conditioning system). Indoor sampling volumes should consider the analytical sensitivity, in order to meet project goals.

Depending on project needs, indoor sampling may consist of static/normal operation conditions or utilizing disturbed/aggressive procedures.

7.5.1 Aggressive Sampling Procedures

Sampling equipment at fixed locations may fail to detect the presence of asbestos fibers. Due to limited air movement, many fibers may settle out of the air onto the floor and other surfaces and may not be captured on the filter. A quick and effective screening to capture asbestos fibers is to circulate the air artificially so that the fibers remain airborne during sampling. The result from this sampling option typifies a worst-case condition, and this is referred to as aggressive air sampling for asbestos. Refer to the site-specific QAPP and HASP prior to initiation of site activities.

1. Before starting the sampling pumps, direct forced air (such as a leaf blower or large fan) against walls, ceilings, floors, ledges, and other surfaces in the room to initially dislodge fibers from surfaces. This should take at least 5 minutes per 1,000 square feet of floor area.

2. Place a 20-inch fan (or similar piece of equipment) in the center of the room. Place the fan on slow speed and point it toward the ceiling. Use one fan per 10,000 cubic feet of room volume.

3. Follow the procedures described in Sections 7.4.1 and 7.4.2. When sampling is completed, turn off the pump first, and turn off the fans second.

4. Follow the handling procedures described in Section 3.2.

8.0 CALCULATIONS

The sample volume is calculated by multiplying the average flow rate of the pump by the number of minutes the pump was running **(sample volume = flow rate X time in minutes)**. The sample volume should be submitted to the laboratory and identified on the chain of custody for each sample. Note that a sample volume of zero will be indicated for lot and field blanks.

The concentration result is calculated using the sample volume and the numbers of asbestos structures reported after the application of the cluster and matrix counting criteria.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Specific QA/QC activities that apply to the implementation of these procedures will be listed in the QAPP prepared for the applicable sampling event. The following general quality assurance (QA) procedures also apply:

1. All sample collection data, including sample number, sample location, start and end times, start and end flow rates, pump number, media used and analysis/method must be documented on site logbooks or Field Sampling Worksheets.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer or instrument-specific SOPs, unless otherwise specified in the QAPP. Equipment check-out and calibration is necessary prior to sampling and must be done according to the instruction manuals supplied by the manufacturer.

3. Records must be maintained, documenting the training of the operators that use instrumentation and equipment for the collection of environmental information.

The following quality control (QC) requirements are applicable:

9.1 TEM Requirements

1. Examine lot blanks to determine the background asbestos structure concentration.

2. Examine field blanks to determine if there is the presence of contamination associated with extraneous asbestos structures introduced during specimen preparation.

3. Examine laboratory blanks to determine if contamination was introduced during critical phases of the laboratory program.

4. To determine if the laboratory can satisfactorily analyze samples of known asbestos structure concentrations, reference filters can be examined. Reference filters can be maintained as part of the laboratory's QA program.

5. To minimize subjective effects, some specimens should be recounted by a different microscopist.

6. It is preferred that asbestos laboratories be accredited by the National Voluntary Laboratory Accreditation Program (NVLAP).

7. At this time, performance evaluation samples for asbestos in air are not available for Removal Program Activities.

9.2 PCM Requirements

1. Examine reference slides of known concentration to determine the analyst's ability to satisfactorily count fibers. Reference slides should be maintained as part of the laboratory's quality assurance program.

2. Examine field blanks to determine if there is the presence of contamination associated with extraneous structures introduced during sample handling.

3. Some samples should be relabeled then submitted for counting by the same analyst to determine possible bias by the analyst.

4. Participation in a proficiency testing program such as the American Industrial Hygiene Association (AIHA)-NIOSH proficiency analytical testing (PAT) program is recommended.

10.0 DATA VALIDATION

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. This may include but is not limited to: location information, start and end times, sampling method and total volume sampled. These data are essential to providing an accurate and complete final deliverable. The contractor's Task Leader (TL) is responsible for completing the UFP-QAPP verification checklist for each project.

Results of the QA/QC samples will be evaluated for contamination during the data validation process. This information will be utilized to qualify the environmental sample results accordingly with the data quality objectives of the project.

11.0 HEALTH AND SAFETY

Based on Occupational Safety and Health Administration (OSHA) requirements, a site-specific health and safety plan (HASP) must be prepared for response operations under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, 29 CFR 1910.120. Field personnel working for EPA's ERT should consult the Emergency Responder Health and Safety Manual currently located at https://response.epa.gov/_HealthSafetyManual/manual-index.htm for the development of the HASP, required PPE and respiratory protection.

12.0 REFERENCES

Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air, Part 1: Method, EPA/540/2-90/005a, May 1990, and Part 2: Technical Background Document, EPA/540/2-90/005b, May 1990.

Occupational Safety and Health Administration. Code of Federal Regulations 29 CFR 1910.1001. Washington, D.C. 1987.

Methodology for the Measurement of Airborne Asbestos by Electron Microscopy, EPA's Report No. 68-02-3266, 1984, S.C. Agarwal, and R. D. Gibbons.

National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Method, 4th Edition. https://www.cdc.gov/niosh/docs/2003-154/default.html.

National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Method, 5th Edition. https://www.cdc.gov/niosh/nmam/default.html.

U.S. Environmental Protection Agency. Code of Federal Regulations 40 CFR 763. July 1, 1987. Code of Federal Regulations 40 CFR 763 Addendum. October 30, 1987.

U.S. Environmental Protection Agency. Asbestos-Containing Materials in Schools; Final Rule and Notice. 52 FR 41826.

U.S. Environmental Protection Agency. Technology Innovation Program. A discussion of Asbestos Detection Techniques for Air and Soil. August 2004.

U.S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. Framework for Investigating Asbestos-Contaminated Superfund Sites. OSWER Directive: 9200.0-68. 2008.

13.0 APPENDICES

A - Figures

APPENDIX A
Figures
SOP: ERT-PROC-2015-20
June 2020

FIGURE 1. Mixed-Cellulose Ester 0.45 micron Filter Cassette

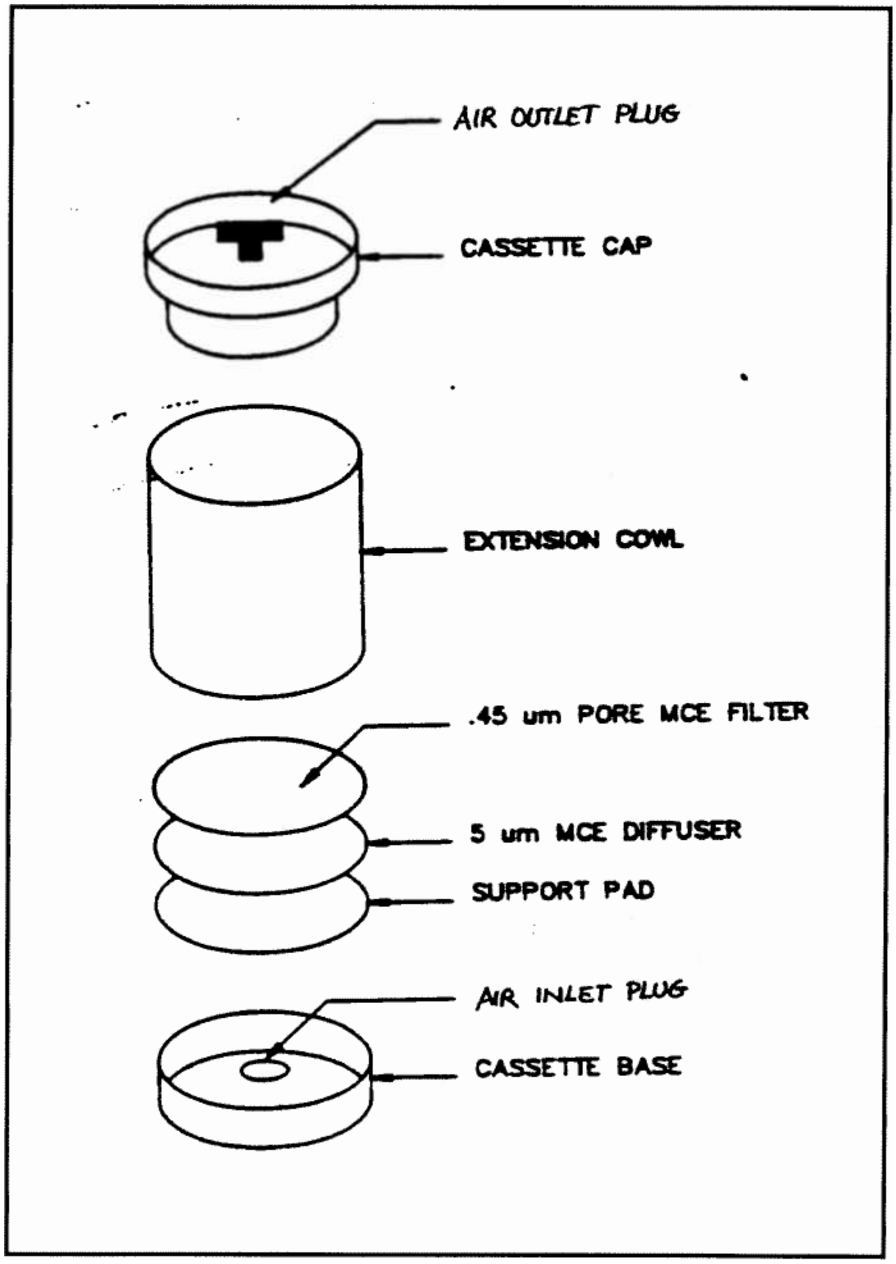


FIGURE 2. Mixed-Cellulose Ester 0.8 micron Filter Cassette

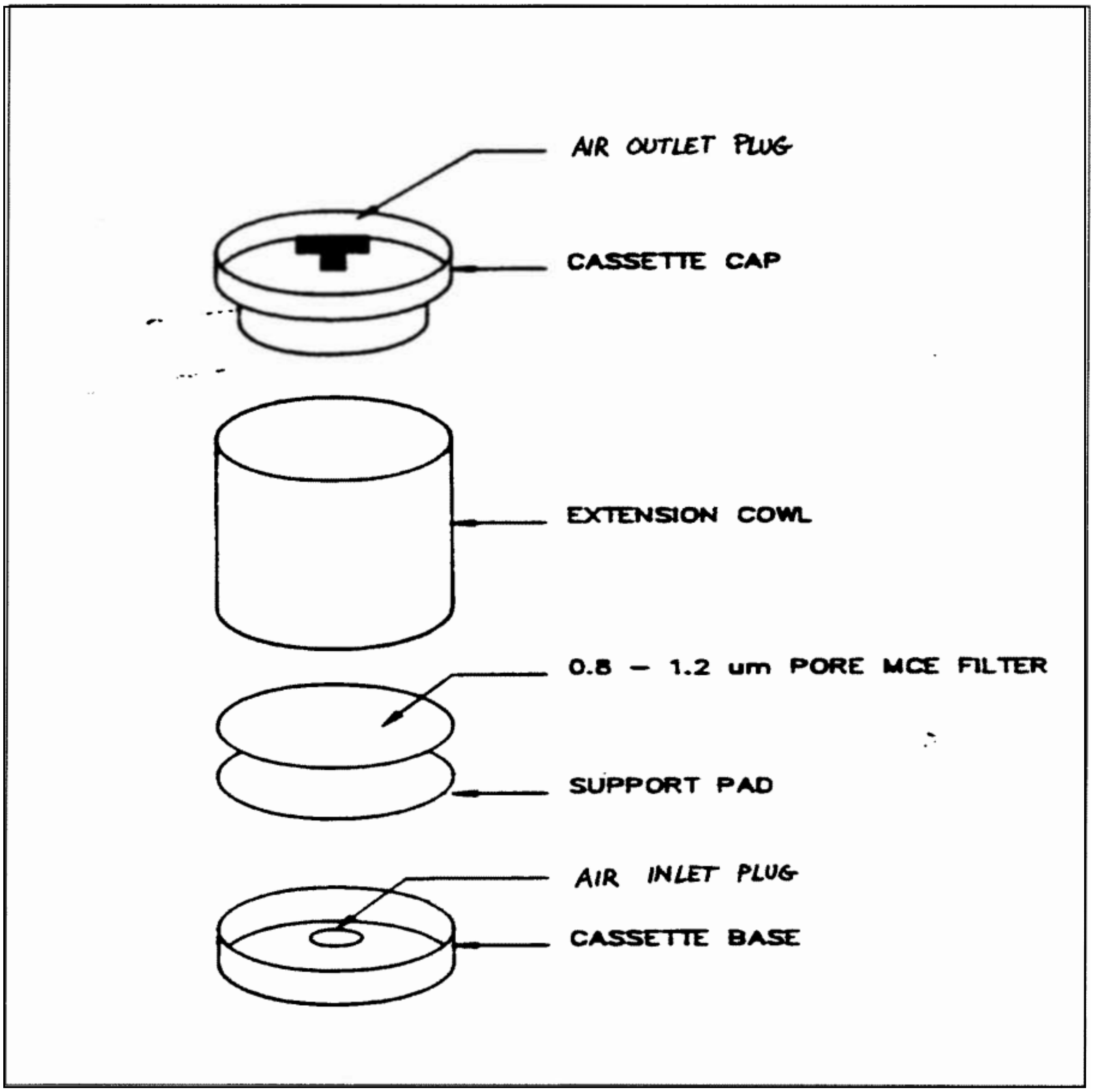


FIGURE 3. Calibration of Personal Sampling Pump Using a Rotameter

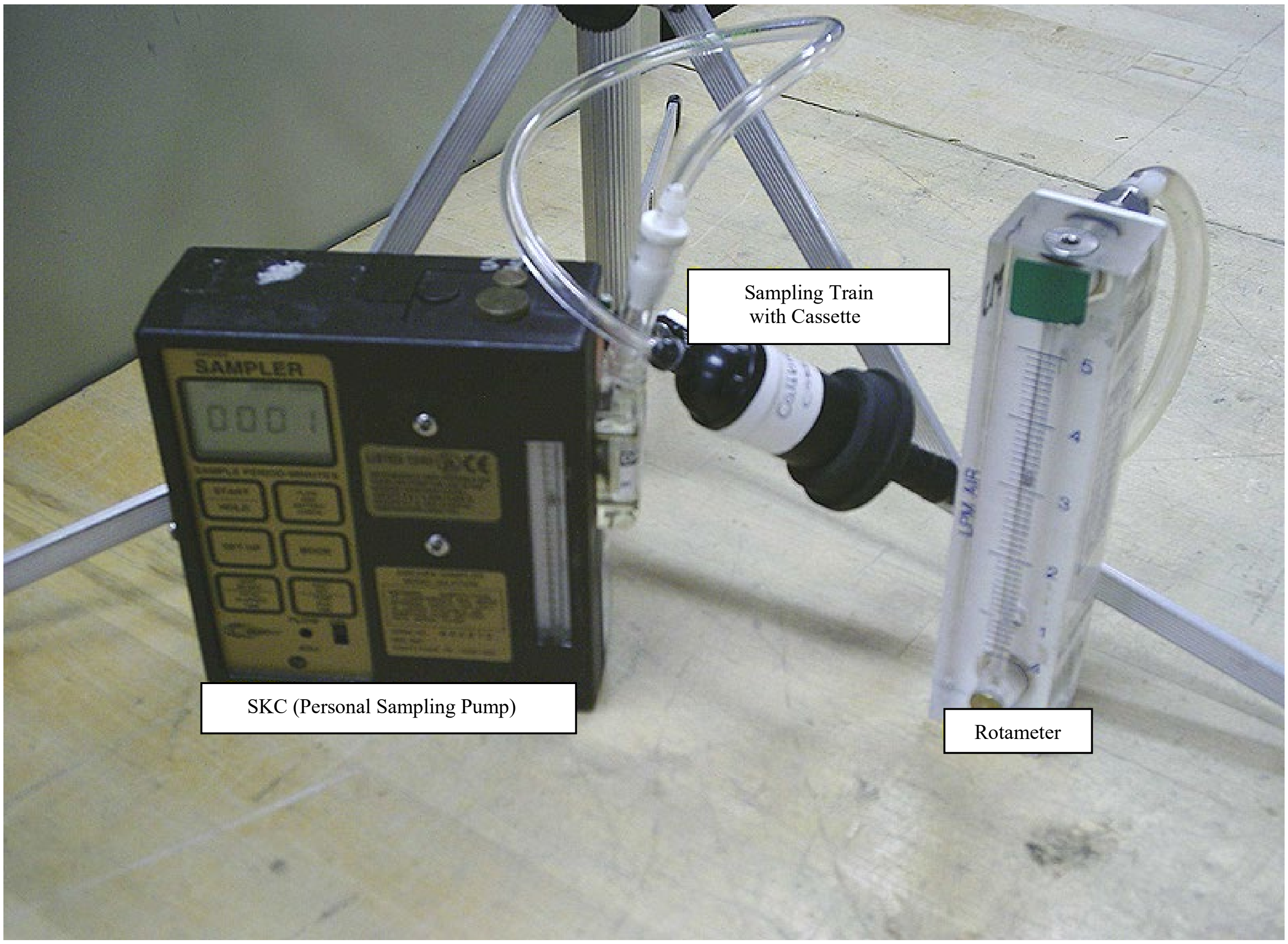


FIGURE 4. Calibration of Personal Sampling Pump with an Electronic Calibrator (DryCal Defender 520)

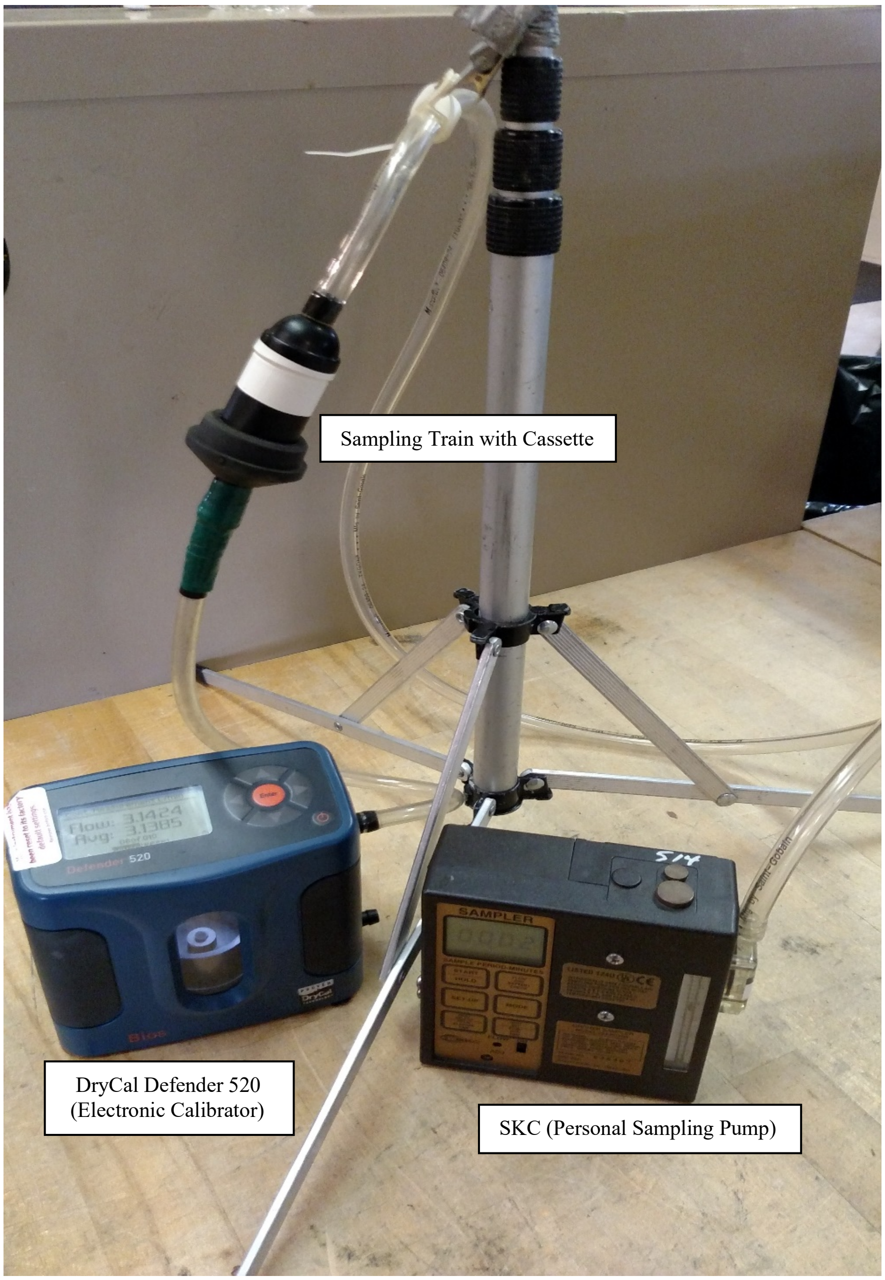
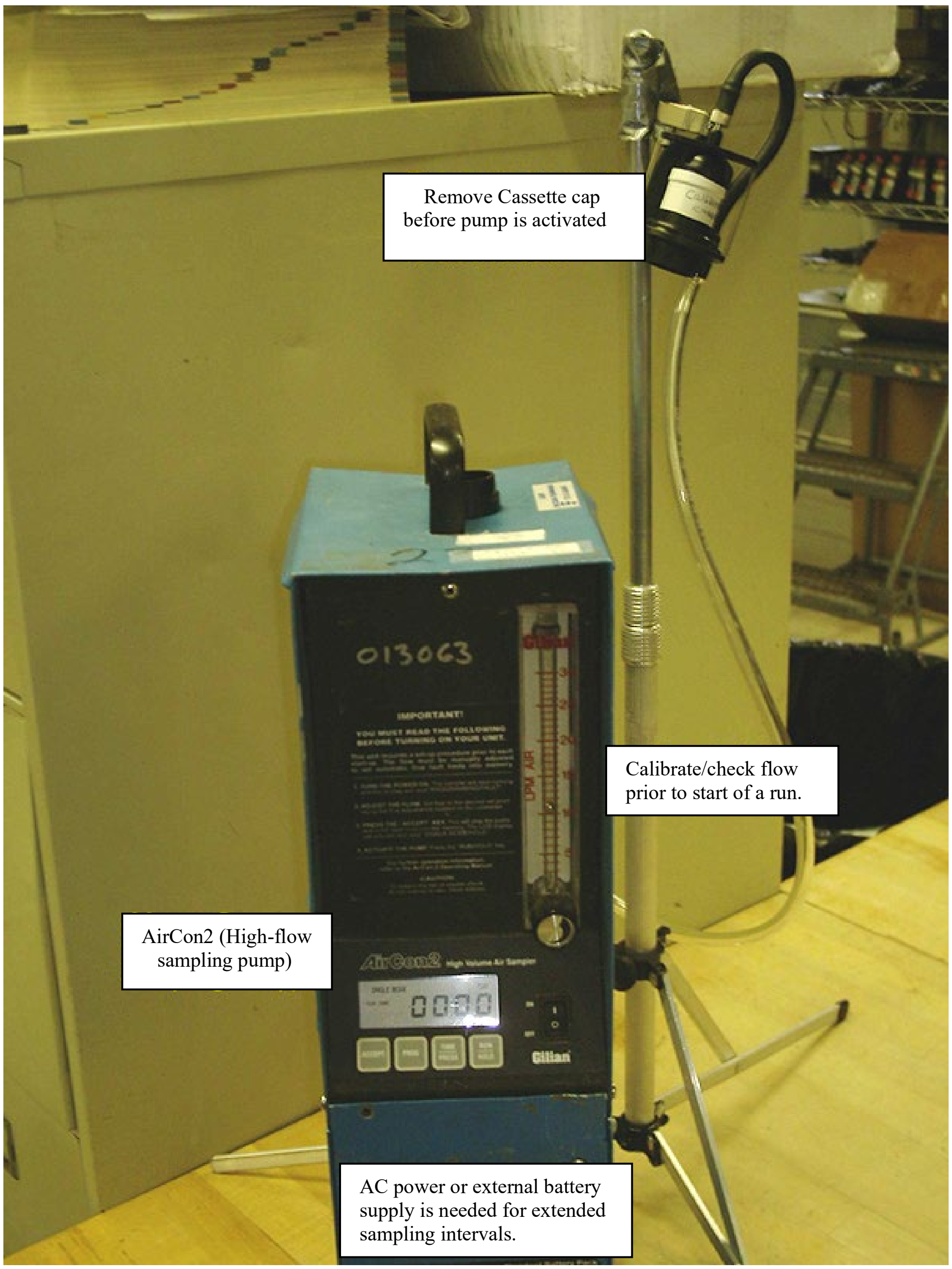


FIGURE 5. Personal Sampling Train for Asbestos

FIGURE 6. High Flow Stationary Sampling Train for Asbestos



CONTENTS

CONTENTS (cont'd))

The policies and procedures established in this document are intended solely for the guidance of OLEM employees of the U.S. Environmental Protection Agency (EPA). They are not intended and cannot be relied upon to create any rights, substantive or procedural, enforceable by any party in litigation with the United States. EPA reserves the right to act at variance with these policies and procedures, and to change them at any time without public notice. EPA strongly encourages all readers to verify the validity of the information contained in this document by consulting the most recent Code of Federal Regulations (CFR) and updated guidance documents.

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1.0 SCOPE AND APPLICATION

Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response (OSWER) Superfund Policy Directive 9345.4-05 - Clarifying Cleanup Goals and Identification of New Assessment Tools for Evaluating Asbestos at Superfund Cleanups - requires EPA Regions to develop risk-based, site-specific action levels to determine if response actions should be taken, when materials containing less than (<) 1 % (percent) asbestos are found at a site, and to outline some activities that will assist in evaluating such risk at Superfund sites. The Framework for Investigating Asbestos-Contaminated Superfund Sites - OSWER Directive 9200.0-68 addresses asbestos at Superfund sites by recommending a risk-based, site-specific approach for site evaluation based on current asbestos science. This guidance provides a recommended flexible framework for investigating and evaluating asbestos contamination at Superfund removal and remedial sites.

The relationship between the concentration of asbestos in a source material and the concentration of fibers in air that results when that source is disturbed is very complex and dependent on a wide range of variables. To date, no method has been found that reliably predicts the concentration of asbestos in air given the concentration of asbestos in the source. The framework emphasizes an empirical approach to site characterization because models to predict airborne asbestos concentrations from soil concentrations have not been validated. Specifically, a combination of soil, dust, and air samples are recommended to characterize exposure. Concentrations of asbestos in air at the location of a source disturbance are measured rather than predicted. Therefore, personal monitoring in the form of activity-based sampling (ABS) is the most appropriate technique to estimate exposure. Personal exposure is influenced by the activities performed, the duration of the activity, and the site-specific soils of interest.

At a number of diverse sites across the country, the U.S. EPA has demonstrated that disturbance of soil with low levels of asbestos (including soil concentrations less than 1.0% as measured by Polarized Light Microscopy (PLM) can potentially result in significant concentrations (greater than [>] 0.1 structures per cubic centimeter [S/cc]) of respirable asbestos fibers in the breathing zone of individuals engaged in various physical activities. This may result in a cancer risk in excess of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) remedial objectives.

Since personal monitoring is more representative of actual exposure than samples obtained from a fixed downwind location (McBride 1999, Rodes 1995, Hildemann 2005), personal monitoring results are generally most relevant for risk characterizations. Thus, the best measure of actual exposure to an individual would be through the collection of personal air samples over the exposure period of interest (National Institute for Occupational Safety and Health [NIOSH] 1977). However, at CERCLA sites, it is neither always possible nor practical to do so. EPA has thus developed a sampling procedure called ABS, designed to mimic the activities of a potential receptor.

As part of ABS, U.S. EPA or contracted personnel trained in hazard recognition and mitigation, serve as surrogates for the potentially exposed populace of interest. ABS simulates routine activities in order to mimic and evaluate personal exposures from disturbance of materials potentially contaminated with asbestos. Similar sampling approaches have been used to assess exposures to pesticides and lead (U.S. EPA 2000) and this technique has long been a cornerstone of industrial hygiene wherein workplace exposures are routinely assessed via personal exposure monitoring.

This document provides guidance for ABS activities or scenarios. Personal monitoring is conducted during various activities such as raking, All-Terrain Vehicle (ATV) riding, rototilling, digging, a child playing in the dirt, power weed cutting, lawn mowing, walking with a stroller, bicycling, playing basketball, or other relevant site activities.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the UFP-QAPP for a particular site. This document is not intended to be used as a substitute for a site-specific UFP-QAPP but rather intended as a reference for developing site-specific UFP-QAPPs.

The procedures in this SOP may be modified, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the UFP-QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

As personal exposure is influenced by the activities performed, the duration of the activities, and the site-specific conditions, it is recommended that a site-specific ABS scenario be chosen or developed. A site-specific ABS scenario will best characterize the potential asbestos human health exposure.

For ABS, a site-specific activity(ies) or scenario(s) is/are selected that represents an activity(ies) or scenario(s) that is/are occurring currently on site or around the site or an activity(ies) or scenario(s) is selected that is likely to occur on the site in the future. Activity(ies) or scenario(s) selected should be comprised of a worse case activity(ies) or scenario(s) to determine the full potential impact to human health.

Once the activity(ies) or scenario(s) is selected, soil samples are collected to determine/confirm concentrations of asbestos in the area for ABS. The area(s) is selected and the ABS is conducted with personnel in PPE while collecting samples from their breathing zone, the perimeter of the ABS area, and the reference/background location. Additional samples may be collected farther from the ABS perimeter to determine how far asbestos is being transported from the ABS area.

Special consideration should be given when characterizing exposure to children as it has been hypothesized that children are more prone to exposure than adults (U.S. EPA 2000) because they tend to be closer to the source. Sample flow rates, duration, and final volume will need to be weighed against the number of counted grid openings (cost factor) to obtain the needed sensitivity. Sampling periods should be of sufficient durations (averaging time) to facilitate collection of a representative sample to achieve the required level of sensitivity.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

3.1 Sample Preservation

No preservation is required for asbestos samples.

3.2 Sample Handling, Container, and Storage Procedures

1. Place a sample label on the cassette indicating a unique sampling number. Do not put sampling cassettes in shirt or coat pockets as the filter can pick up fibers or a static charge that could disturb the dust deposited on the filter media.

2. To the extent possible, samples should be handled gently with the filter inlet facing upward to avoid disturbing the particulate deposited on the filter and to minimize the potential of imparting a static charge to the cassette, which might alter the particulate deposition on the filter media.

3. Place the cassette individually in a manila-type envelope or other appropriate container that will not relay a static charge to the cassette. Under extremely low humidity conditions (less than 10% relative humidity), plastic bags such as Ziploc or Glad can develop a static charge that may affect the particle distribution of the filters. Each envelope should be marked with the sample identification number, total volume and date.

4. To the best extent possible, the sampling cassettes in the manila envelopes should be placed right side up so that the cassette inlet cap is on top and cassette base is on bottom (International Organization for Standardization [ISO] 10312). Place samples into a shipping container and use enough packing material (e.g., bubble wrap) to prevent jostling or damage. Samples must be handled gently so as not to disturb the dust deposited on the filter media. Do not use vermiculite or any other type of fibrous packing material for samples. If possible, carry the samples by hand to the laboratory.

5. Provide appropriate documentation with samples (i.e., chain of custody and requested analytical methodology).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 Area Selection

When selecting areas for ABS, consideration should be given to the potential for off-site migration of contaminants and possible exposure to the public. Particulate migration off-site should be minimized, and constraints or mitigation protocols should be established to minimize public exposure. These constraints/mitigation protocols may include restricting public access to the area, conducting the ABS in remote areas of the site, dust suppression using water mist, building a containment structure, etc. Air sampling should be conducted to document the airborne concentration of asbestos at the site perimeter during activities.

4.2 Flow Rate Considerations

For activities that generate a large quantity of dust (i.e., particulates), sample flow rates may need to be reduced accordingly to avoid overloading the filters. For example, a sampling pump flow rate of approximately 1.0 liter per minute (L/min) for a 30-minute period was found most effective at one site for monitoring for asbestos while riding ATVs on dusty soils, while high soil moisture and reduced particulate generation at another site permitted a 5.0 L/min flow rate for up to 2-hours.

High flow rates may result in filter damage due to failure of its physical support associated with increased pressure drop, leakage of air around the filter mount so that the filter is bypassed, or damage to the asbestos structures (breakup of bundles and clusters) due to increased impact velocities (ISO 10312). High flow rates can also disrupt or tear the filters during initial pump startup due to the shock load placed on the filter when the pump is first started.

Sampling larger volumes of air and analyzing greater areas of the filter media can theoretically lower the limit of detection indefinitely. In practice, the total suspended particulate (TSP) concentration limits the volume of air that can be filtered, as TSP can obscure asbestos fibers. The ISO Method 10312 states that the direct analytical method cannot be used if the general particulate loading exceeds approximately 25% coverage of the collection filter. An airborne concentration of approximately 10 micrograms per cubic meter ($\mu g/m^3$), corresponding to clean rural air, results in approximately 10% coverage of the filter media based on a 4,000-liter (L) sample.

The following formula from ISO 10132 may be used to calculate the analytical sensitivity:

$$S = \frac{A_t}{K A_g V}$$

Where:
S = Analytical sensitivity expressed in structures per liter (S/L)
A_t = Active area in square millimeters (mm^2) of the collection media or filter
A_g = Mean area in mm^2 of the grid openings examined
K = Number of grid openings examined
V = Volume of air sampled, in liters (L)

NOTE: 25-millimeter (mm) cassettes have an effective filter area of 385 mm^2 and 37-mm cassettes have an effective filter area of 855 mm^2. The typical grid opening is 0.0057 mm^2. Note: Grid size will vary between laboratories; therefore, dimensions should be verified prior to calculating the number of grid openings that must be counted to achieve a particular level of sensitivity.

Table 1 provides an example of the minimum number of grid openings that must be counted to achieve various sensitivities and detection limits (DLs).

It is frequently more efficient to employ collocated samplers to collect a high and low volume of air. This increases the likelihood of at least one of the two samples being readable using the direct analytical method (ISO 10312) than to lose the sample due to overloading or having to analyze by the indirect method (ISO 13794).

4.3 Transmission Electron Microscopy Specimen Preparation Methods

It can be argued that direct methods yield an under-estimate of the asbestos structure concentration because other particulate material with which they are associated conceals many of the asbestos fibers present. Conversely, indirect methods can be considered to yield an over-estimate because some types of complex asbestos structures disintegrate during the preparation, resulting in an increase in the numbers of structures counted.

It is left to the end user to determine which Transmission Electron Microscopy (TEM) specimen preparation method should be utilized. It is recommended that all relevant site participants meet and consult with a risk assessor well in advance of any sample collection.

If direct transfer TEM sample preparation is preferred, it is suggested that a microscope be brought to the site with the sampling team. With rapid information on overloading, adjustments in sample flowrate can be made quickly, preventing unnecessarily overloaded samples.

4.3.1 ISO 10312 Direct-Transfer TEM Specimen Preparation Methods

Direct-transfer TEM specimen preparation methods have the following interferences:

- This method cannot discriminate between individual fibers of asbestos and elongate fragments (cleavage fragments and acicular particles) from non-asbestos analogues of the same amphibole mineral.

- Complete identification of every chrysotile and/or amphibole fiber is not possible due to instrumental limitations and the nature of some of the fibers. Additionally, complete identification of every amphibole fiber is not practical due to the limitations of both time and cost.

- On rare occasions, some amphibole fibers can visually be misidentified as chrysotile. Particles of other minerals having visual compositions similar to those of some amphiboles could be erroneously classified as amphibole. Use of energy dispersive X-ray analysis (from the method) can eliminate the misidentification.

- The achievable detection limit (DL) is restricted by the particulate density on the filter, which in turn is controlled by the sampled air volume and the total suspended particulate concentration in the atmosphere being sampled.

- The precision of the result is dependent on the uniformity of the deposit of asbestos structures on the sample collection filter.

- Air samples must be collected so that they have particulate and fiber loadings within narrow ranges. If too high of a particulate loading occurs on the filter, it may not be possible to prepare a satisfactory TEM specimen by the direct-transfer method and an accurate fiber count may not be possible.

4.3.2 ISO 13794 Indirect TEM Specimen Preparation Methods

For the indirect preparation method the membrane filter, or a portion of it, is placed on a microscope slide, sample face downward and ashed in a low temperature Plasma Asher until complete calcination of the filter is achieved. The ash is then recovered in distilled water and the solution is then filtered on a polycarbonate filter. The indirect transfer method re-distributes the particulate on a new membrane filter.

Indirect TEM specimen preparation methods have the following interferences:

- The size distribution of asbestos structures is modified (clusters, matrices bundles, etc. may be broken up during sample preparation).

- There is increased opportunity for fiber loss or introduction of extraneous contamination from laboratory glassware, process water, etc.

  When sample collection filters are ashed, any contamination in the filter medium is concentrated in the new TEM specimen

- There is a possibility of misidentification of fibers for which both the morphologies and the electron diffraction (ED) patterns are reported based on visual observation only. This can be rectified by the use of energy-dispersive x-ray analysis (EDXA) and the observation of the 0.73 nanometer (nm) reflection of chrysotile in the ED pattern.

- Particles of a number of other minerals may have compositions similar to amphiboles. These could be classified as amphibole when the classification criteria does not include zone-axis ED techniques

The direct analytical method (ISO 10312) is the preferred method and every reasonable effort should be made to prevent overloading of the filter. Samples that are overloaded may, at the discretion of the project management team, be analyzed by ISO Method 13794 “Ambient air – Determination of asbestos fibres – Indirect-transfer transmission electron microscopy method” (ISO 2019). Results of the ISO 13794 analysis should be reviewed separately from the ISO 10312 samples and a decision made regarding combining the two data sets should be discussed with the site toxicologist/risk assessor. The QAPP should contain information on when ISO 13794 is used and what decisions may be made with the data.

4.4 Analytical Sensitivity

Sample volumes and detection/quantification limits should be specified in the site-specific QAPP with flow rates and sampling periods adjusted accordingly. Typical sensitivity limits that have been employed for risk assessment have been approximately 0.001 S/cc for ABS samples and 0.0001 S/cc for background or reference sample locations. These limits can vary and should be determined in advance. Based on ISO 10312 (Table 1 of Section 11), a sensitivity limit of 0.001 S/cc would require a sample volume of greater than 500 L to keep the number of grid openings to be counted below 100 in order to keep analytical costs under control. In dusty environments overloading may occur. Therefore, lower sample volumes may need to be collected. Similarly, a sample volume greater than 5,000 L would be required to reach 0.0001 S/cc with fewer than 100 grid openings to count.

Sampling volumes will be determined, based on the analytical sensitivity required for a particular task. The sensitivity is defined as the structure concentration corresponding to the detection of one structure by ISO 10312. Sensitivities can vary from project to project and within tasks on a project. The desired sensitivity can be met through a combination of volume collected and number of filter grids counted by the microscopist for the TEM by the direct transfer method. Limit of detection is usually defined as 3 times the analytical sensitivity. Before collecting any samples, consult with the end line stakeholders, toxicologists and risk assessors in the early stages of project planning in order to determine the required analytical sensitivity.

The following example, of number of grids to be counted, is a condensed excerpt from the Code of Federal Regulations Chapter 40 Part 763, Subpart E, Appendix A. In this example, the number of grids to be counted will reflect an analytical sensitivity of 0.005 structures per cubic centimeter from a 25-millimeter (mm) filter with an effective area of 385 mm^2.

Volume in Liters	Grid Openings
600	23
1200	11
1800	8
2400	6
3000	5
3600	4

Once the desired analytical sensitivity is determined, an agreement between the risk assessor, project leader, and sampling personnel must be reached to determine how to reach that analytical goal. The question to be asked is "What is the preferred method to reach the sensitivity?" A higher sample volume or additional grid counting by the laboratory? Cost may be a factor. Increasing sample volumes could double the length of the sampling event, while counting additional grids will increase costs. It is imperative that these details are clarified well in advance of field work.

4.5 Sampling Cassette Orientation

Air sampling cassettes must be oriented with the open face pointing down to preclude large non-respirable particles from falling or settling onto the filter media.

5.0 EQUIPMENT/APPARATUS

- Battery powered personal sampling pumps capable of providing a constant flow-rate of 1.0 L/min up to 4.0 L/min for the time to achieve the desired volume of air sampled. Note that some, but not all personal sampling pumps are capable of 5 L/min.

- Battery or alternating current higher flow sampling pumps (i.e., QuickTake 30 or AirCon-2), capable of providing a constant flow-rate of 8.0 to 16 L/min for the time to achieve the desired volume of air sampled. Note that the AirCon-2 is capable of achieving flow rates as low as 2 L/min. If AC power is not available, a generator should be obtained. The generator should be positioned downwind from the sampling pumps.

- Mixed cellulose ester (MCE) filter cassettes with conductive extension cowls, typically 0.8 micrometer (µm), 25-mm diameter, purchased from a certified vendor with appropriate documentation of low filter background counts, consistent filter area and certified leak-free cassettes (SKC 225-321 or equivalent). MCE filter cassettes 0.45-µm, 25-mm diameter (SKC 225-327 or equivalent) may also be used. However, higher flow rates will not be able to be achieved due to backpressure issues with the sampling pumps. Filter selection should be discussed with the site toxicologist/risk assessor and documented in the QAPP.

Additional Equipment

- Sampling train setups (Sensidyne Gilian 800143, SKC 225-1 or equivalent)
- Tygon tubing, with Luer (Gilian 200156 or equivalent) type adaptor
- Backpacks
- Sampling stands (SKC Model Tripod Stand 228-506 or equivalent)
- Duct tape
- Tools, miscellaneous (e.g., screwdrivers, pliers, cutting tool, etc.)
- Envelopes, manila-type (coin size #6 preferred)
- Sample labels
- Logbook and/or sampling worksheets
- Scribe supplies
- Precision rotameter or primary flow standard appropriate for sampling flow rate
- Personal protective equipment (PPE), including but not limited to respirators, boots, gloves, eye protection, hard hat, to be determined based on type of activity and possible exposure

- Decontamination equipment (Plastic sheeting, Liquinox, buckets, brushes, water, Hudson sprayers, garbage bags, etc.)
- Power sources (line power, solar recharging batteries, power inverters, generators, etc.)

6.0 REAGENTS

None required.

7.0 PROCEDURES

7.1 Pre-Site Sampling Preparation

1. Have and comply with approved Health and Safety Plan (HASP) and UFP-QAPP.
2. Determine the extent of the sampling effort (number of locations, repetitions, number of samples, etc.), the sampling methods to be employed, and the types and amounts of equipment and supplies needed from the QAPP.
3. Obtain necessary sampling equipment, ensure it is in working order, and fully charged (if necessary).
4. Perform a general site survey prior to site entry in accordance with the site-specific HASP.
5. Once on site the instrument calibration is performed in the clean zone and the pumps are then deployed to their sampling locations. The calibration procedures are listed below.

7.2 Calibration Procedures

To determine if a sampling pump is measuring the flow rate or volume of air correctly, it is necessary to calibrate the equipment. Sampling pumps should be calibrated on a routine basis and prior to use. Preliminary calibration should be conducted using a primary or secondary calibrator with a representative filter cassette installed between the pump and the calibrator. The representative sampling cassette can be reused for calibrating other pumps that will be used for asbestos sampling. The same cassette lot used for sampling should also be used for the calibration. A sticker should be affixed to the outside of the extension cowl marked "Calibration Cassette."

Constant flow calibration readings are obtained before and after sampling. If the flow rate changes by more than 5% during the sampling period, the average of the pre- and post-calibration rates will be used to calculate the total sample volume. The sampling pump used will provide a non-fluctuating air-flow through the filter, and the flow rate should be maintained within 10% of the initial volume flow rate throughout the sampling period. The value of these flow-rate measurements will be used to calculate the total air volume sampled. A constant flow or critical orifice controlled pump meets these requirements. If at any time the measurement indicates that the flow-rate has decreased by more than 30%, the sampling may be terminated. The end user of the data will determine if the sample should be analyzed. Flexible tubing is used to connect the filter cassette to the sampling pump. Sampling pumps can be calibrated prior to coming on-site to reduce the amount of time spent performing on-site calibration activities.

7.2.1 Calibrating a Personal Sampling Pump with a Rotameter

1. For U.S. EPA Environmental Response Team (ERT) rotameters perform calibrations following directions established in ERT SOP, *Rotameter Calibration.*

2. Set up the calibration train using a rotameter, sampling pump and the sampling cassette that will be used during the sampling event. The sampling trains may be set up prior to field mobilization and will be checked in the field prior to use.

3. To set up the calibration train, attach one end of the tubing (approximately 2 feet) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap or open-faced calibration adapter to the rotameter. Insure that the tubing and rotameter used to calibrate the pump do not restrict the airflow.

4. The flow meter should be as level as possible when recording flow rates.

5. Turn the sampling pump on.

6. Turn the flow adjust screw (or knob) on the sampling pump until the float ball on the rotameter is lined up with the pre-calibrated flow rate value on the rotameter. Note: rotameters should be marked with the previous calibration date and corresponding flow rates and scale. Confirm the flow rate after approximately 10 seconds. Adjust flow rate accordingly.

7. A verification of calibration is generally performed on site in the clean zone immediately prior to the sampling.

7.2.2 Calibrating a Personal Sampling Pump with an Electronic Calibrator

1. Refer to the manufacturer's manual for operational instructions. Ensure that the unit has been calibrated within the past year.

2. Set up the calibration train using a sampling pump, electronic calibrator, and the actual sampling cassette or a representative filter cassette. The same lot of cassettes used for sampling must also be used for calibration.

3. To set up the calibration train, attach one end of tubing (approximately 2 feet) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap or open-faced calibration adapter to the electronic calibrator.

4. Turn the electronic calibrator and sampling pump on. Select a flow rate to calibrate.

5. Turn the flow-adjust screw or knob on the pump until the desired flow rate is attained on the rotameter. Confirm the flow rate after approximately 10 seconds. Adjust flow rate accordingly. Record the flow rate and calibrator information.

7.3. Meteorology

It is recommended that an on-site, portable, 3-meter meteorological station be established. If possible, sample after 36 hours of dry weather when wind conditions are representative for the climatology of the location based on month and time of day. Wind speed, wind direction, temperature and station pressure should be recorded on the meteorological station data logger and real-time data should be available for review. Suggested meteorological station specifications can be found in Table 2, Appendix A. Alternatively, a nearby representative meteorological station, may be used to acquire the necessary data.

7.4 Soil Moisture

As stated previously, sampling should be performed during periods of dry weather that are climatologically representative of the area being studied. Soil moisture plays a major role in determining potential exposure. If the objective of the ABS activity is to be conducted during the worst-case conditions, the sampling should be conducted under the driest conditions possible. It is up to the discretion of the EPA site manager to determine the objective of the site work.

General Historical Data

Soil moisture will vary by region and by time of year. Soil moisture and precipitation information is available through the Climate Prediction Center and the National Weather Service.

The simplest way to see when the driest time of year to conduct sampling, would be is to utilize a climatological average map. While not precise, this graphic approximates the depth of water in millimeters (mm) of the top meter of soil. Use the monthly tabs to view the data. The map can be accessed by the following link:

https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilwet_clim.shtml#

An example national map depicting a 30-year climatological average soil moisture can be found in Appendix B. These maps are available for each month.

Station Specific Precipitation Data

Throughout the country are meteorological observation stations. Many of these stations can provide details of their average monthly rainfall data. Appendix C provides a step-by-step procedure to determine average precipitation data for many areas throughout the country.

Soil Moisture Determination

For most ABS studies, soil moisture has been determined by one of two ways either in the field using a field screening instrument (non-destructive) giving a volumetric water content (VWC) or by drying a sample in the field or at a laboratory for a gravimetric determination (destructive).

Field screening instrumentation determines soil moisture by providing a percentage of VWC. This can happen quickly in the field. VWC is defined as the volume of water divided by volume of soil sample.

A gravimetric analysis (i.e., ASTM 2216) determines soil moisture by comparing the weight of a sample before and after drying. This method involves initially weighing the sample as collected and then drying in an oven at 110˚C (± 5˚C). After cooling to room temperature, the dry sample is weighed. The mass of water is calculated by subtracting the dry weight from the wet weight. The percentage of soil moisture is calculated by the dividing the mass of water by the mass of the dry sample and multiplying by 100.

Volumetric soil moisture is related to gravimetric soil moisture when the GWC is multiplied by the bulk soil density. Bulk soil density can be calculated by dividing the dry soil mass by the volume of soil.

Soil bulk density can be derived at the time of the gravimetric analysis and will vary based on the type of soil being measured. Soil bulk density is the ratio of the dry soil mass to the soil sample volume. If the soil bulk density is not readily available, some typical soil densities were found (Yu et al 1993) to range from 1.2 grams per cubic centimeter (g/cc) for clay to 1.52 g/cc for sand.

Soil type information is found through the US Department of Agriculture's, Natural Resource Conservation Service web site: https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

Soil bulk density will vary with each sample collected. Most research papers base their soil moisture content on the gravimetric method.

As shown above, the volumetric water content of soil will be higher than the gravimetric water content.

For simplicity of field-based decisions, it is recommended to use field screening instruments (by VWC) to make the decision prior to performing ABS. It is highly recommended that these instruments have an annual calibration certificate and have the ability to be field checked or field calibrated prior to use. Multiple instruments should be available during the sampling event due to instrument variability and fragility. Instruments that have been utilized in the past include the Omega HSM50 Series and the Extech MO750.

<u>What is the acceptable amount of moisture in the soil?</u>

Some literature suggests that a contaminant release from a soil disturbance would be inhibited if the soil moisture exceeds 10% by gravimetric means (12% to 15% VWC). Based on these studies and in conjunction with EPA's goal of addressing potential risk to public health under reasonable maximum exposure situations, an average soil moisture level of 10% (12% to 15% VWC) or less should be considered the optimum level when conducting ABS. Given the fact there is a great amount of variability across the country in terms of average or typical soil moisture conditions based primarily on annual or seasonal precipitation variability, the risk manager must ask if 10% is a realistic expectation in the area of concern. It may be in the southwest, but in the northwest or the southeast, soil moisture may exceed 10% (GWC) as a normal condition.

Under abnormally wet conditions for any given region if ABS cannot be delayed, additional options can be employed with the consent of the EPA decision maker to obtain sample results without the bias of the abnormally wet soils. Refer to Section 7.6.12 Alternative ABS Methods for additional information.

Sampling should be delayed if rainfall has exceeded 1/4-inch in the past 36 hours, unless it can be demonstrated that the acceptable soil moisture content can be achieved. Activity-based samples should be collected under conditions when the soil is relatively dry and average moisture levels do not exceed 10% (12% to 15% VWC). As previously stated, when sampling in a region where typical soil moisture and/or average annual/seasonal precipitation levels make it highly unlikely that soil moisture levels will fall below 10%, even during abnormally dry periods, then ABS could proceed with approval of the EPA decision maker using an average soil moisture content of less than 25% VWC (17% to 21% GWC).

Soil moisture should be measured within each sampling area (grid) using a soil moisture meter prior to collection of ABS air samples. For each area, soil moisture will be collected from a minimum of 10 locations at a depth based on the scenario (see Appendix A, Table 3). The average of the 10 locations should equal 10% or less (or 25% or less depending on the location of the site as described above).

ABS activities should be considered above the 25% average only in rare situations. The organization responsible for the field activities needs to demonstrate that the observed soil moisture conditions are typical and/or reasonable for the area. The EPA official responsible for the site must be in agreement with the decision to continue with the ABS activity; and that these conditions have been discussed in the approved site specific QAPP. Any variation of these conditions must be documented on a field change form, providing the data quality objectives are not altered. The burden of proof lies with the organization responsible for performing the ABS activities. This organization may wish to consult with ERT and/or the Asbestos Technical Review Workgroup (TRW) prior to initiation of site activities.

Depth of Soil Moisture Measurement

The depth at which the soil moisture measurements are collected should mimic the depth of the soil collection recommendations from Appendix A, Table 3. If the instrument requires the measuring probe to be deeper than the depth listed in Table 3, field personnel should collect soil from the anticipated ABS affected depth and place it into a sampling jar. Add the soil to the jar so that the soil moisture probe can be placed at the manufacturer's recommended depth for proper soil moisture measurements.

7.5 General Sampling Information

For all activity-based sampling events, except as noted otherwise, collect asbestos samples from the breathing zones of the event participants. Each activity or scenario participant will don appropriate PPE. The backpack utilized during the scenario generally contains high- and low-flow sampling pumps fitted with appropriate type of cassettes secured to the shoulder straps near the operator's lapels in the breathing zone. The breathing zone can be visualized as a hemisphere approximately 6 to 9 inches around an individual's face. Breathing zone samples provide the best approximation of the concentration of contaminants in the air that an individual is actually breathing. Specific breathing zone heights should be determined on a project-by-project basis based on the anthropometrics for the study population and the participants' positions during the performance of each task.

If it is necessary to relieve a participant from the activity, another sample collector should be suited and ready to participate in the ABS prior to the personnel exchange. The participant will stop the activity, remove the backpack or belt and pass it to the relief participant similar to the transfer of a baton in a relay race. The original participant will assist the relief participant with donning and adjusting the backpack or belt. The exchange is anticipated to take less than 60 seconds, therefore the sampling pumps and event time clock will not be halted during the exchange. If the exchange requires more than 60 seconds, the pump and event clock will be stopped until activity is re-initiated. Alternatively, extend the scenario for the "lost" time.

For all asbestos sampling, an asbestos sampling train consisting of 0.8-µm or a 0.45-µm, 25-mm MCE filter connected to a sampling pump is used. Specify the filter pore size in the UFP-QAPP. The top cover from the cowl extension on the sampling cassette will be removed ("open-face") and the cassette oriented face down for all asbestos filters. All samples should be collected open-faced unless a specific requirement for sampling closed-faced exists.

For activity-based sampling, calibrate sampling pumps to collect between 2 and 12 L/min of air through the filter depending on the pump capacity and analytical goals. Dusty conditions may dictate lower flow rates. The flow rate is based upon the duration of time required to collect the target volume that meets the site-specific analytical sensitivity limit as specified in the UFP-QAPP.

Generally, each activity based sampling event should be repeated a minimum of three times in the same area, or if not possible, in an area with similar asbestos soil concentrations, to determine trends, demonstrate data reproducibility, or assess variability. This can be accomplished by a single participant repeating the activity three or more times or by having a single simulation in three areas with similar asbestos soil concentrations. If soil moisture or seasonal variability is a concern, three events for each different season or meteorological condition may be appropriate. The decision to conduct multiple repetitions of an activity in a single area should be based on the data quality objectives of the project and specified in the UFP-QAPP.

During most ABS activities, participants may be fitted with two sampling pumps or samplers may be collocated to sample a high and low volume of air to increase the likelihood of at least one of the two samples being analyzed using the direct analytical method (ISO 10312) without overloading. Ideally, a volume of 560 L (based on 40 Code of Federal Regulations [CFR] 763) should be collected for the low-flow samples, and a volume up to 4,000 L should be collected for the high-flow samples. Volumes less than 560 L may be collected if the decision makers are in agreement and the sampling design is documented in a site specific QAPP. The targeted high volume is typically 1,200 L, which permits counting approximately 54 grid openings for a sensitivity level of 0.001 S/cc. Based on Table 1 of Appendix A, additional grid openings may be used if a lower sample volume must be collected (Refer to Section 4.4 for additional information).

7.6 Site-Specific Activity-Based Sampling Scenarios

If site-specific ABS is undertaken, the number and types of activities and the types of scenarios should be based on current and/or potential land use and potential impact to adjacent property. As potential hazardous dust is produced, every effort must be taken to minimize exposure on or off-site. The activity selected may also be used to assess the effectiveness of institutional or legal controls placed on the future use of the land. Land use assumptions should be based on a factual understanding of site-specific conditions and reasonably anticipated use. The land use evaluated for the assessment should be based on a residential exposure scenario (i.e., the default worst-case) unless residential land use is not plausible for the site. Future land use assumptions should be consistent with reasonably anticipated future land use based on input from planning boards, appropriate officials and the public. The site-specific scenario and the area selected to perform the scenario in should be identified and substantiated in the UFP-QAPP.

The following sections discuss a partial list of potential ABS scenarios that can be conducted on site. If implementation of other scenarios is necessary, use professional judgement to develop and execute the scenario and associated sampling activities.

7.6.1 Raking

The raking scenario is appropriate for all sites with soils potentially contaminated with asbestos. ABS should be performed in a grid pattern to evaluate the potential for fiber release from soil over a portion of the site. If the analytical results are above the criteria that were derived for the site, then remediation or institutional controls should be implemented, or additional site-specific ABS should be undertaken. If the analytical results are below the criteria that were derived, then no further action may be necessary.

In this activity or simulation, a participant will rake a lawn or garden area to remove debris such as rocks, leaves, thatch, and/or weeds using a leaf rake (or bow rake), with a rake width of approximately 20 to 28 inches. Participants should strive to disturb the top half-inch of soil with an aggressive raking motion. This depth will vary based on the objective of the scenario specified in the UFP-QAPP.

Each raking participant donning appropriate PPE will be fitted with a high and low flow sampling pump contained in a backpack with the cassette secured to the shoulder straps near the operator's lapels in the breathing zone. A typical low sampling pump flow rate can vary from 1 to 5 L/min. A high flow sampling pump rate can vary from 2 to 12 L/min

Personnel will rake a lawn or garden area to remove debris for a minimum of 1 to 2 hours (flow rate and sensitivity level dependent). Raking will occur in a measured area specified in the QAPP with vegetation, soil or rocks/gravel and will occur in an arched motion raking from one side of the participant to the other. As an example, the participants may rake the debris towards themselves facing one side of the square for 15 minutes then the participant will turn 90 degrees clockwise and begin a new side. Participants may continue to rake each side of the square and rotate 90 degrees. Unique shaped parcels can be addressed using logic and best professional judgement. Once several small piles of debris have been made, the participant may pick up the debris and place it in a trash can. The sequence of raking, rotating and picking up debris shall be repeated for the duration of the sampling period. The participant should stay in the same sampling area or grid for the entire sampling period.

7.6.2 ATV Riding

This scenario might be appropriate for recreational areas or other areas where ATVs are typically ridden where asbestos contamination is present. This activity is designed to be representative of one, two, or more ATV participants riding on a course or trail. Riders should maintain their relative position (lead, middle, and tail) throughout the activity.

Each ATV rider wearing appropriate PPE may be fitted with two personal sampling pumps set at two distinct flow rates, to collect high and low flow samples, due to filter overloading concerns. The cassettes for the personal sampling pumps should be attached to the shoulder straps of the backpack proximal to the riders' lapels in the breathing zone. It may be beneficial to attach a dust monitor (e.g., DustTrak or equivalent) to the tail ATV to record dust levels and gauge dust loading. The sampling pumps can be carried in a backpack while the dust monitor, if used, can be mounted to the ATV.

Personnel will ride the ATVs around a course at the same time until a sufficient volume of air has been collected to achieve the required sensitivity limit. The riders, one lead rider and one following rider, will vary the vehicle speed between 5 and 30 miles per hour (mph). Riders will strive for an average speed typical of riders in the area, but ideally 10 mph. The average speed is a target speed only; vehicle speeds will be adjusted to meet track conditions. Vehicles will be equipped with a speedometer and odometer to record speeds and distance traveled. ATV riding and sampling may be conducted for 30 to 120 minutes in duration, depending on dust loading and required detection limits. The ATVs may be equipped with a global positioning system (GPS) unit or utilize an appropriate phone application to estimate average speed and distance traveled.

ATVs and ATV tires are selected as appropriate for the area under investigation. Specifically, the size (i.e., weight, horsepower, etc.) of the ATV should be appropriate for the study area. The vehicle tires should have a tread pattern that is representative of those typically used in the area. Local ATV shops or ATV clubs can be consulted for guidance.

7.6.3 Child Playing in the Dirt

This scenario might be appropriate for sites where schools, playgrounds, parks, or residential areas, etc. are contaminated with asbestos with the overarching criteria being areas where a child might be expected to play or dig in the dirt. This scenario was designed to be representative of a child playing in the dirt with a shovel and pail.

The event participant wearing appropriate PPE may be fitted with high and low flow personal sampling pumps; the inlet to the filter will be at a height of approximately 1 to 3 feet above the ground to simulate a child's breathing zone. The actual pump units should be secured in a backpack or on the belt of the participant.

A participant should sit on the ground while digging or scraping the top 2 to 6 inches of surface soil, placing it in a small bucket or pail and dumping it back on the ground. The activity should be paced such that soil will be placed in the bucket and dumped approximately every two to five minutes, regardless of the amount of material in the bucket. The bucket should be emptied rapidly from a height of approximately 12 inches, based on observations of two to four-year-olds playing in a sandbox.

A sampling period and flow rate to collect a sufficient volume of air will be determined as to achieve the project-specific detection/quantification limit. The sampling period can be divided into equal sub-periods to facilitate having the participant face each compass direction for an equal amount of time during the activity. This approach is designed to mitigate the effect of wind direction on potential exposure. Random head and body movement during the activity should further mitigate the impact of wind direction on exposure. Ideally, the participants should face each compass direction at least twice during the sampling event. For example, during a two-hour or 120-minute event, the participant might face North for 15 minutes, rotate to the East for 15 minutes, then South for 15 minutes, then West for 15 minutes and return to the North to repeat the cycle. Participants should attempt to move to a fresh patch of soil after the completion of each cycle (360-degree rotation).

7.6.4 Gardening/Rototilling

This scenario might be appropriate for sites where gardening or surface disturbance to a depth of approximately one foot is anticipated. This activity is designed to be representative of individuals participating in gardening activities using a rototiller.

Each rototilling participant donning appropriate PPE will be fitted with high- and low-flow sampling pumps. The actual pump units may be contained in a backpack with the cassette secured to the shoulder straps near the operator's lapels in the breathing zone.

Personnel will operate a rototiller for one to two hours to loosen soil in the yard to a depth of approximately 12 inches. The depth chosen is area-specific and will need to be determined on a case-by-case basis. A rear-tine rototiller in the six to eight horsepower range should be selected. Other types or sizes of tillers may be appropriate based on the soil conditions and type of gardening being conducted.

A 100 to 720-square-foot (ft^2) plot of land should be selected to till. The average size of a community garden in New Jersey was 720 ft^2 based on a survey conducted by Rutgers University in 1991 (Patel 1991). The edges will be delineated. Square plots are preferred. The rototiller operator should conduct typical associated activities such as removing rocks and debris from the tilled area. To account for the effects of varying wind direction on potential exposure, the operator should till the soil back and forth towards each side of the square continuously for 10 minutes, shut down the machine or place it in neutral, and rake or sort through the material for five minutes. The operator should then turn 90 degrees in a clockwise direction and repeat the previous 15-minute procedure. The operator should continue to rotate 90 degrees clockwise every 15 minutes until the one to two-hour sampling period is complete. The participant should stay in the same plot for the entire sampling period.

7.6.5 Weed Cutting

This scenario might be appropriate for sites where lawn maintenance might be conducted such as in residential and commercial areas. This activity is designed to simulate a person trimming weeds and grasses with a gas or electric powered weed cutter.

Each weed-cutting participant may be fitted with high and low flow personal sampling pumps. The pump units can be contained in a backpack with the cassette secured to the shoulder straps near the operator's lapels in the breathing zone. Personnel wearing appropriate PPE will operate a gas or electric-powered string trimmer. Ideally, a 25 to 35-cubic centimeter (cc) gas or electric-powered trimmer with a 16 to 18-inch cutting swath is selected. Trimming and edging will occur in a measured area with thick vegetation (typically 100 to 720-ft^2, based on a typical residential garden) (Patel 1991). Trimming should be performed using a side to side sweeping motion with the operator moving in a series of straight lines back and forth towards one side of the selected area for 10 minutes, resting five minutes, and turning 90 degrees in a clockwise direction before repeating this 15-minute procedure for the duration of the sampling period. The participant should stay in the same plot for the entire sampling period.

7.6.6 Digging

Digging might be appropriate for sites where construction projects are likely to occur or where plants might be planted. Digging will occur in a measured area with vegetation, soil or rocks/gravel.

Each participant donning appropriate PPE may be fitted with high and low flow personal sampling pumps contained in a backpack with the cassette secured to the shoulder straps near the operator's lapels in the breathing zone. The participants should dig a hole to approximately two feet deep and two feet in diameter (representative of planting a small shrub or digging a fencepost; site-specific dimensions should be specified in the UFP-QAPP) (Vodak 2004), and place the soil next to the hole. The participants should then refill the hole with the soil that had been removed. Upon refilling a hole, participants should rotate 90 degrees in a clockwise direction and continue to dig and refill additional holes until the sampling period is complete. The sequence of digging, filling, and rotating should be repeated for the duration of the sampling period.

7.6.7 Lawn Mowing

Lawn mowing may be appropriate for sites where lawn maintenance may be conducted, such as residential and commercial areas.

Each lawn-mowing participant may be fitted with high and low flow personal sampling pumps contained in a backpack with the cassette secured to the shoulder straps near the operator's lapels in the breathing zone. Personnel wearing appropriate PPE will operate a gas or electrically powered lawn mower. Mowing should occur in a measured area with thick vegetation and should occur in a shrinking square pattern. Participants will divide the area into a number of squares that decrease in size towards the center of the square by the width of the mower swath. Mower blades should be set at approximately 2 to 2.5 inches, but the mower blade settings may vary based on the thickness of the vegetation to be cut. A bagless, side-discharge 3- to 5-horsepower lawn mower should be used for this exercise. The mowing operation should be repeated for the duration of the sampling period.

7.6.8 Walker with Stroller

This scenario might be appropriate for sites such as parks, paths, trails, or open-space. The high and low flow personal sampling pump units may be secured in a backpack. The cassette for the personal sampling pumps may be attached to the shoulder straps of the backpack proximal to the walker's lapel in the breathing zone. A second set of pumps should be placed in the stroller with the filter inlets in a child's potential breathing zone.

During these events, walkers wearing appropriate PPE pushing a stroller should walk back and forth along a portion of a path until a sufficient volume of air has been collected to achieve the required detection limit. The walkers should vary their speed between 1.5 and 4 mph. Walkers should strive for an average speed of 2 mph. The average speed is a target speed only; speeds will be adjusted to meet trail conditions. Walkers may be equipped with a GPS unit or utilize an appropriate phone application to estimate average speed and distance traveled.

7.6.9 Jogging

This scenario might be appropriate for sites such as parks, paths, trails, or open-space. The high and low flow pump units may be secured in a backpack. The cassette for the personal sampling pumps may be attached to the shoulder straps of the backpack proximal to the jogger's lapel in the breathing zone.

During these events, joggers wearing appropriate PPE will run/jog back and forth along a portion of a path until a sufficient volume of air has been collected to achieve the required detection limit. The joggers should vary their speed between 2.5 and 5 mph. Joggers should strive for an average speed of 4 mph. The average speed is a target speed only; speeds can be adjusted to meet trail conditions. Joggers may be equipped with a GPS unit or utilize an appropriate phone application to estimate average speed and distance traveled.

Two or more joggers can participate in this activity. When multiple joggers participate, they should maintain their relative position throughout the event (lead, middle, and tail). Joggers should be spaced five feet apart.

7.6.10 Two Bicycles

Bicycling might be appropriate for sites such as parks, paths, trails, or open-space. Two bicyclists wearing appropriate PPE should ride back and forth with one leading and one following along the length of the on-site portion of a path, or ride around a site (no trail) until a sufficient volume of air has been collected to achieve the required detection limit.

The bicycling participants may each be fitted with high and low flow personal sampling pumps. The actual pump units may be contained in backpacks with the cassettes secured to the shoulder straps near the cyclists' lapels in the breathing zone.

During these events, the bicycle riders may vary their speed between 3 and 15 mph. Riders should strive for an average speed of 8 mph. The average speed is a target speed only; adjust bicycle speeds to meet trail conditions. Bicycles may be equipped with a GPS or utilize an appropriate phone application to estimate average speed and distance traveled. Riders should maintain their relative position (lead and tail) throughout the activity.

7.6.11 Basketball Scenario

This scenario might be appropriate for sites where basketball courts are present. The basketball scenario was developed to simulate a group of recreational basketball players gathering to play a casual game of basketball for 60 to 120 minutes on an outdoor concrete or macadam court. Between four and 10 players wearing appropriate PPE can participate in this exercise. Personnel wearing appropriate PPE can be fitted with high and low flow personal sampling pumps contained in a backpack with the cassette secured to the shoulder straps near the operator's lapels in the breathing zone.

Suggested Scenarios:

- Two of the players may sweep the court with push brooms from the perimeter of the court to the center. While these two people are sweeping the court, the remaining personnel should mill about under the basket and take a few shots.

- Shot practice participants stand around the key as for a free throw, with the exception that one of the participants is positioned under the basket to retrieve the ball after each shot. The player closest to the basket on the left side (facing the basket) takes two shots and the ball/shooter rotates counter-clockwise after those two shots. Each person shoots consecutively until everyone has taken two shots. The entire group then rotates clockwise. This sequence should be repeated until time expires. Ideally, each player should shoot from each key position and take a turn retrieving the ball under the basket.

- Each player takes turns practicing lay-ups. All players line up on the left side of the basket (facing the basket) and shoot one after another. The first person shoots then retrieves the ball for next person in line and so on. Players can use two basketballs with the second person bouncing the ball outside of the key as the first person shoots. Players should run a full cycle from left then a full cycle from right; repeating the left, right cycles until the interval time is up.

- Shot practice as described above may be conducted.

- A half-court game may be played to the degree practical.

- A lay-up drill as described above may be conducted.

7.6.12 Alternative ABS Methods

Alternative ABS methods may be considered in situations where traditional ABS activities cannot be performed. These conditions could be areas:

- Where soil moisture content may be above project-specific limits,
- Where the population may be considered to be too close to a study area, or
- When used for comparability between study areas.

7.6.12.1 Ex Situ Child's Play Scenario

The Ex Situ Child's Play Scenario (also known as the bucket of dirt scenario) utilizes a representative composite soil sample collected in a filled 5-gallon bucket. The composited soil can be placed in a secure dry location and allowed to dry naturally over time, or actively dried. Reassess the soil moisture periodically. Once soil moisture drops below 10%, the activity can proceed.

The Ex situ Child's Play scenario should be performed in an isolated location in an area prepared with visqueen sheeting surrounded by a berm of wood boards to create a barrier around the sampling area. This scenario is designed to be representative of a child playing in the dirt with a shovel and pail, similar to section 7.6.3.

The event participant wearing appropriate PPE may be fitted with high (4-6 L/min) and low (1-3 L/min) flow personal sampling pumps; the inlet to the filter will be at an eventual height of approximately 1 to 3 feet above the ground to simulate a child's breathing zone while seated. The actual pump units should be secured in a backpack or on the belt of the participant.

A participant should sit on the ground and empty the 5-gallon soil sample on the sheet. The scenario will consist of using a trowel to re-fill the bucket and dumping it back on the ground. The participant will continue to fill and empty the bucket for a sampling period and flow rate to collect a sufficient volume of air to achieve the project-specific detection/quantification limit. A typical timeframe is 45 to 60 minutes; visually inspect the filter during the scenario to prevent overloading.

For each soil sample, perimeter sample(s) (high flow) should be collected to ensure that asbestos is not getting outside the containment area. As this scenario is typically used with soil associated with low levels of contaminants, only a few samples maybe needed. The amount of these samples collected will depend on the number of iterations detailed in the site specific QAPP.

7.6.12.2 Fluidized Bed Asbestos Segregator (FBAS)

Another alternative method to help determine the risk associated with asbestos in soil, utilizes the fluidized bed asbestos segregator (FBAS). Soil, or other solid media, is collected from an area of interest. It is size-segregated by sieving and the fine fraction is then homogenized and fluidized in the FBAS. Small particles are elutriated from the bulk material and collected on a filter. The filter is then analyzed by TEM for identification and quantitation of fibers. The concentration of fibers in the soil can be expressed either as asbestos structures per gram (S/g) of soil or as mass percent (g of asbestos per 100 g of soil).

EPA has continued development and evaluation of the FBAS as it has become commercially available. For details on the use of FBAS, refer to Other Test Method 42: Sampling, Sample Preparation and Operation of the Fluidized Bed Asbestos Segregator here:
https://www.epa.gov/sites/production/files/2020-08/documents/otm_42_sampling_sample_preparation_and_operation_of_fluidized_bed_asbestos_segregator.pdf.

7.7 Cumulative Exposure Scenario

A cumulative exposure study may be appropriate for sites where individuals move about a site during the course of a day, with varying levels of exposure at multiple indoor and outdoor locations. The objective is to estimate aggregate and cumulative exposure to asbestos over the course of a day. Cumulative exposure studies should be conducted in order to increase understanding of linkages between sources of asbestos and subsequent exposure and dose to humans for use in mitigating risk and reducing exposure and disease.

Over periods of weeks, years or decades, exposures to environmental agents, such as asbestos, occur intermittently rather than continuously. The occurrence of long-term health effects, such as cancer, however, are routinely projected based on an average dose over the period of interest (typically years), rather than as a series of intermittent exposures. Consequently, long-term doses are usually estimated by summing doses across discrete exposure episodes and then calculating an average dose for the period of interest (e.g., year, lifetime, etc.).

For the cumulative exposure studies, times of up to 24-hours can be considered. Owners/residents should not be asked to wear personal air samplers to assess exposure. ABS actors should be instructed to mimic a particular routine of what may be considered a typical day. A log of activities should be maintained.

A minimal description of exposure for a particular route must include exposure concentration and the duration. This is the method of choice to describe and estimate short-term doses, where integration times are of the order of minutes, hours or days. When projecting long-term exposures, for years or a lifetime, since it is typically impractical to sample for the entire exposure period, short-term exposure estimates are assumed representative of long-term periods and are integrated to estimate long-term exposures, typically with a safety factor to account for variability. Observations of activities should be recorded throughout each cumulative exposure study, together with the other relevant factors including locations and activities during the study.

Samples are collected using a personal air pump with a flow rate of between 1 to 5 L/min. Samples shall be collected open-faced with the inlet facing downward at a personal breathing zone height of 4 to 6 feet for 24 hours. Because the battery life for a personal monitor is typically eight to 10 hours, the pump should be changed out at approximately 8-hour intervals (keeping the same filter cassette). Each pump is pre-calibrated prior to use. Wear each monitor at normal breathing height during all waking hours. During sleep, place the monitor in the same room as the sleeping individual. The sampling cassette will be placed proximal to the breathing zone of the reclined participant.

Should a study subject participate in a high dust generating activity such as riding an ATV, the 24 hour sampling cassette event should be paused and a short-term exposure sample should be collected on a separate cassette with an appropriately calibrated sampling pump. Once the high dust activity has been terminated, the original 24-hour cassette and pump should be resumed for the remainder of the sampling period. Results of the two or more samples, depending on the number of high dust generating events should be summed to derive the total 24-hour exposure data.

7.8 Background Sampling

Background (sometimes referred to as a reference sample location) samples should be considered for all sampling events and should be addressed in a site-specific UFP-QAPP. These samples are strongly recommended for all outdoor sampling events and encouraged for any indoor sampling. A background sample is defined as a sample collected upwind. while a reference sample location can be collected away from the immediate sampling area at a distance sufficient to prevent being influenced by the simulated activities and may be on or off the site. To the degree practical, the area selected for background sampling should be free of known asbestos contamination. For outdoor sampling, consider collecting samples outdoors in a manner consistent with Asbestos Hazard Emergency Response Act (AHERA) clearance sampling as per 40 CFR, Appendix A to Subpart E of Part 763. The background level should reflect the concentration of asbestos in air for the environmental setting on or near a site or activity location. The background level may not represent pre-release conditions or conditions in the absence of influence from sources at the site. A background level may or may not be less than the detection limit, but if it is greater than the detection limit, it should account for variability in local asbestos concentrations. Background samples may be collected concurrently with ABS using stationary sampling pumps. Background samples should not be impacted by the site ABS. Sampling and analytical parameters (sample volume grid opening count, etc.) should be prescribed to permit a detection limit approximately an order of magnitude below that of the ABS detection limit.

An Aircon-2 sampling pump (or equivalent) should be calibrated to collect 10 L/min for on-site and off-site air samples through the filter. The flow rate will allow a minimum target volume to meet the required sensitivity limit. Lower volume air samples may be collected concurrently at the ambient air sampling locations. If overloading of the filter is a concern, personal sampling pumps may also be utilized with the same media at a flow rate between 2 and 3 L/min in order to collect a lower sample volume. The ideal target sensitivity of these samples can be as low as the higher volume samples when additional grids are counted in accordance with the method. Collocated samples are collected to sample a high and low volume of air to increase the likelihood of at least one of the two samples being readable using the direct analytical method (ISO 10312).

7.9 Perimeter Sampling

Perimeter air sampling should be performed to determine the concentrations of asbestos at the activity perimeter or the site perimeter and to ensure that ABS activities do not result in excessive airborne asbestos emissions from the site.

Perimeter samples are defined as samples collected upwind, downwind, or crosswind of a specific activity. When selecting areas for ABS, consideration should be given to the potential for off-site migration of contaminants and to possible exposure to the public. Within the constraints of ABS, to the degree practical, particulate migration off site should be minimized, and constraints or mitigation protocols established to eliminate public exposure. These constraints/mitigation protocols may include conducting the ABS in remote areas of the site, dust suppression adjacent to the activity area using water mist, building a containment structure, etc. Air sampling should be conducted to document the airborne concentration of asbestos at the activity/site perimeter during activities. Perimeter air monitoring should be conducted to:

- Document air quality during ABS and establish perimeter levels of asbestos during site activities
- Monitor and document air quality during site activities near sensitive receptors
- Provide risk management information and address public concerns
- Reduce possible liabilities associated with ABS

An AirCon-2 sampling pump (or equivalent) can be calibrated to collect 10 L/min for on-site and off-site air samples through the filter. The flow rate will allow a target volume that will provide the required sensitivity limit. Lower volume air samples may be collected concurrently at the perimeter sampling locations using personal sampling pumps, if loading is an issue. These pumps will be utilized with the same media at a flow rate of between 2 and 3 L/min. The target sensitivity of these samples can be as low as the higher volume samples when additional grids are counted in accordance with the method.

7.10 Soil Sampling

The relationship between the concentration of asbestos in a source material (typically soil) and the concentration of fibers in air that results when the source is disturbed is very complex and depends on a wide range of variables. It is reasonable to say that besides the asbestos fiber concentration in soil, soil moisture, partial size distribution, and soil type generally have a significant impact on the concentration of asbestos released into the air during ABS.

A sufficient number of soil samples should be collected to characterize the study area. The sampling approach should be designed to collect information to support project decisions. In some cases, grab samples may be appropriate to inform nature and extent; however, incremental composite sampling is recommended to characterize exposure and support risk-based decisions. A sampling design program such as the Visual Sampling Plan is recommended for calculating the number and location of samples with the appropriate confidence intervals.

Soil analytical methods that may be considered include: US EPA 600/R/93/116, *Test Method: Method for the determination of asbestos in bulk building materials*, CARB 435, *Determination of asbestos content of serpentine aggregate*: Method 435 and ASTM Method 7521-16, *Standard test method for determination of asbestos in soil*. Soil sampling should be conducted in accordance with ERT SOP, *Soil Sampling.*

Additionally, soil characteristics should be documented in conjunction with the activity-based personal exposure monitoring using a portable soil moisture meter. Alternatively, soil characteristics can be documented in one of the following ways:

- Using American Society of Testing and Materials (ASTM), Method D2488 - 00: *Description and Identification of Soils (Visual-Manual Procedure)*,
- Soil moisture by ASTM Method D2216-05*: Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass* and grain size by ASTM Method D6913-04e1: *Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis,* or
- Method D422-63 (2002): *Standard Test Method for Particle-Size Analysis of Soils.*

Soil samples should be representative of the soil being disturbed or used during ABS activities. Table 3 of Appendix A provides examples of soil sampling depths, which may be disturbed by the activity being performed.

8.0 CALCULATIONS

The sample volume is calculated from the average flow rate of the pump multiplied by the number of minutes the pump was running (volume = flow rate X time in minutes). The sample volume should be submitted to the laboratory and identified on the chain of custody for each sample (zero for lot, and field blanks).

The concentration result is calculated by dividing the number of asbestos structures reported after the application of the cluster and matrix counting criteria by the sample volume (concentration = number of asbestos structures/sample volume).

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Specific Quality Assurance/Quality Control (QA/QC) activities that apply to the implementation of these procedures will be listed in the QAPP prepared for the applicable sampling event. The following general QA procedures also apply:

1. All sample collection data, including sample number, sample location, start and end times, start and end flow rates, pump number, media used and analysis/method must be documented on site logbooks or Field Sampling Worksheets.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer or instrument-specific SOPs, unless otherwise specified in the UFP-QAPP. Equipment checkout and calibration is necessary prior to sampling and must be done according to the instruction manuals supplied by the manufacturer.

3. Records must be maintained, documenting the training of the operators that use instrumentation and equipment for the collection of environmental information.

The following specific QC activities apply:

1. Provide one field blank per sampling event or per 20 samples, whichever is greater, unless otherwise specified in the analytical method or project-specific UFP-QAPP. The field blank should be

collected at the beginning of the sampling event and handled in the same manner as the sampling cassette except that no air is drawn through it.

2. Lot blanks should be collected at a rate of at least one per lot.

3. It is recommended to collect one collocated sample per sampling event or per 10 samples, whichever is greater. Collocated samples are two samples collected adjacent to each other at the same time at the same flow rates. See the project-specific UFP-QAPP for final determination.

For TEM analysis, the following QA/QC procedures apply:

1. Examine lot blanks to determine the background asbestos structure concentration.

2. Examine field blanks to determine whether there is contamination by extraneous asbestos structures during specimen preparation or handling.

3. Examine laboratory blanks to determine if contamination is being introduced during critical phases of the laboratory program.

4. To determine if the laboratory can satisfactorily analyze samples of known asbestos structure concentrations, reference filters can be examined. Reference filters should be maintained as part of the laboratory's QA program.

5. To minimize subjective effects, some specimens may be recounted by a different microscopist.

6. Asbestos laboratories must be accredited by the National Voluntary Laboratory Accreditation Program (NVLAP).

7. At this time, performance evaluation samples for asbestos in air are not commonly available for Removal Program Activities; however, they should be considered on a case-by-case basis.

10.0 DATA VALIDATION

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. This may include but is not limited to location information, start and end times, sampling method and total volume sampled. These data are essential to providing an accurate and complete final deliverable. The ERT contractor’s Task Leader (TL) is responsible for completing the UFP-QAPP verification checklist for each project.

Results of QC samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

Based on Occupational Safety and Health Administration (OSHA) requirements, a site-specific HASP must be prepared for response operations under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, 29 CFR 1910.120. Field personnel working for EPA’s ERT should consult the Emergency Responder Health and Safety Manual currently located at https://response.epa.gov/_HealthSafetyManual/manual-index.htm for the development of the HASP, required PPE and respiratory protection.

For all ABS, appropriate PPE, including protective coveralls, gloves and footwear, and a respirator with HEPA filter cartridges (P-100 or equivalent) should be worn to protect participants. Details regarding PPE and other protective measures should be specified in the site-specific HASP. Special consideration should be given to the physical safety of the event participants as well as heat stress associated with performing vigorous activities in impermeable clothing.

12.0 REFERENCES

40 CFR Part 763 Asbestos Worker Protection.

American Society for Testing and Materials. 2016. *Standard Test Method for Determination of Asbestos in Soil, ASTM Method 7521-16.*

Berman, Mark, Anthony Kolk, 2000. DRAFT: Modified Elutriator Method for the Determination of Asbestos in Soil and Bulk Materials, Revision 1.California Environmental Protection Agency. 1991. *Determination of asbestos content of serpentine aggregate: Method 435.*

Campbell Scientific, 2001. Application Note 2S-I, Soil Water Status: Content and Potential https://s.campbellsci.com/documents/us/technical-papers/soilh20c.pdf

CMD 2012. *Sampling and Analysis Plan, 2011 Miscellaneous Activity-Based Sampling, Libby Asbestos Site, Operable Unit 4*, Revision 2 – June 2012

Hildemann, L. 2005. Major Sources of Personal Exposure to Airborne Particulate Matter, Seminar at EPA Region IX, March 15, 2005.

International Organization for Standardization. 2019. *Ambient air - Determination of asbestos fibres - Direct-transfer transmission electron microscopy method,* Method 10312.

International Organization for Standardization. 2019. *Ambient air - Determination of asbestos fibres - Indirect-transfer transmission electron microscopy method,* Method 13794.

Januch, Jed. 2005. EPA Region 10 Standard Operating Procedure 10-1EU-001, Standard Operating Procedure for Sampling Airborne Asbestos Fibers in a Laboratory Enclosure- a Qualitative Procedure.

McBride, SJ et al. 1999. Investigations of the proximity effect for pollutants in the indoor environment. J Expo Anal Environ Epidemiol. 1999 9(6): 602–621. Nov–Dec.

National Institute for Occupational Safety and Health. 1977. Occupational Exposure Sampling Strategy Manual, Publication No. 77-173, January 1977.

Patel, Ishwarbhai, "Gardening's Socioeconomic Impacts", Journal of Extension, Volume 29, Number 4, Winter 1991, http://www.joe.org/joe/1991winter/a1.php, accessed June 2020.

Rodes, CE., Kamens, RM and Wiener, RW. 1995. Experimental considerations for the study of contaminant dispersion near the body. Am Ind Hyg Assoc J: 56: 535–45.

SKC Inc. Field Rotameters, https://www.skcinc.com/catalog/pdf/instructions/37505.pdf accessed June 2020.

U. S. Department of Agriculture 2020, Natural Resource Conservation Service, Web Soil Survey, https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx, accessed October 2020.

U.S. EPA. 1993. *Test Method: Method for the determination of asbestos in bulk building materials*. EPA/600/R/93/116.

U.S. EPA. 2000. *Strategy for Research on Environmental Risks to Children*, EPA/600/R-00/068, Office of Research and Development.

U.S. EPA. 2004. *Clarifying Cleanup Goals and Identification of New Assessment Tools for Evaluating Asbestos at Superfund Cleanups*, OSWER Directive 9345.4-05, August 10, 2004.

U.S. EPA. 2008. *Framework for Investigating Asbestos-Contaminated Superfund Sites*, OSWER Directive 9200.0-68, September 10, 2008.

U.S. EPA. 2015. *Investigation of Indoor Environments at Asbestos-Contaminated Superfund Sites*, OSWER Directive 9200.3-101, March 2015.

U.S. EPA. 2018. Other Test Method 42 – Sampling and Sample Preparation and Operation of a Fluidized Asbestos Bed Segregator, U.S. EPA Air Emission Measurement Center (EMC), July 2018

Vodak, Mark C., Arthur J. Vrecenak, 2004. Transplanting Trees and Shrubs. New Jersey Agricultural Experimentation Center, Rutgers Cooperative Research & Extension, Agricultural Experiment Station, Rutgers, The State University of New Jersey, Fact Sheet 376.

Wroble et. al., 2020. Refinement of Sampling and Analysis Techniques for Asbestos in Soil, *Environmental & Engineering Geoscience*, Vol. XXVI, No. 1, February 2020, pp. 129–131.

Yu et. al., 1993. Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil https://www.researchgate.net/publication/241958123_Data_collection_handbook_to_support_modeling_the_impacts_of_radioactive_material_in_soil/figures?lo=1

13.0 APPENDICES

A – Tables
B – Example 30-Year Climatological Average Soil Moisture Map
C – Procedure to Locate Local Average Precipitation Data

APPENDIX A
Tables
SOP: ERT-PROC-2084-21
March 2021

TABLE 1. Minimum Number of Grid Openings Required To Be Counted to Achieve a Given Analytical Sensitivity and Detection Limit (Adapted from ISO 10312)

Analytical Sensitivity Structures/cc	Limit of Detection Structures/cc	Volume of Air Sampled (Liters)					
		500	1,000	2,000	3,000	4,000	5,000
0.0001	0.0003	1,066	533	267	178	134	107
0.0002	0.0006	533	267	134	89	67	54
0.0003	0.0009	358	178	89	60	45	36
0.0004	0.0012	267	134	67	45	34	27
0.0005	0.0015	214	107	54	36	27	22
0.0007	0.0021	153	77	39	26	20	16
0.001	0.003	107	54	27	18	14	11
0.002	0.006	54	27	14	9	7	6
0.003	0.009	36	18	9	6	5	4
0.004	0.012	27	14	7	5	4	4
0.005	0.015	22	11	6	4	4	4
0.007	0.021	16	8	4	4	4	4
0.01	0.030	11	6	4	4	4	4

TABLE 2. Suggested Meteorological Station Specifications

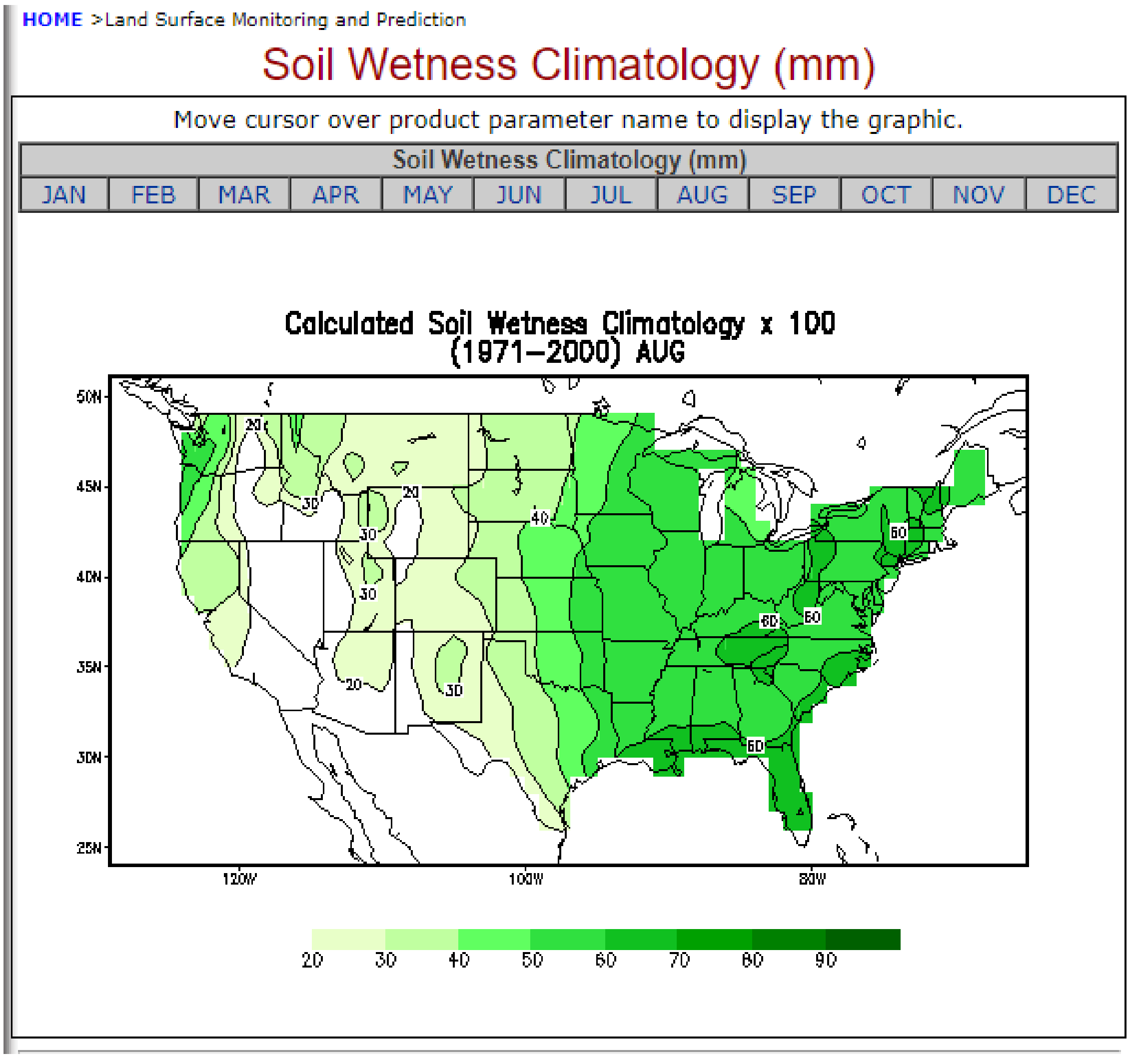
Variable	Accuracy	Resolution
Wind Speed (horizontal and vertical)	± (0.2 m/s + 5% of observed)	0.1 m/s
Wind Direction (azimuth and elevation)	± 5 degrees	1.0 degrees
Ambient Temperature	± 0.5° C	0.1° C
Precipitation	± 10% of observed or ± 0.5 mm	0.3 mm
Pressure	± 3 mb (0.3 kPa)	0.5 mb
Solar Radiation	± 5% of observed	10 W/m^2

m/s = meters per second
°C = degrees Centigrade
mm = millimeters
mb = millibar
W/m^2 = watts per square meter
kPa = kilopascal

TABLE 3. Recommended Soil Sampling Depth Based on Activities Performed

Activity Based Sampling Scenario	Soil Sampling and Soil Moisture Depth
Raking (metal garden or bow rake)	Surface to 3 inches
Raking (leaf rake)	Surface to 2 inch
ATV riding	Surface to 2 inch
Rototilling	Surface to 12 inches
Digging	Surface to depth of excavation
Child Playing in the dirt	Surface to 3 inches
Weed Whacking	Surface to 2 inches
Lawn Mowing	Surface to 2 inch
Walking with Stroller	Surface to 2 inch
Two Bicycles	Surface to 2 inch
Activities on solid surfaces such as asphalt or concrete	Microvacuum ASTM D 5755

APPENDIX B
Example 30-Year Climatological Average Soil Moisture Map
SOP: ERT-PROC-2084-21
March 2021

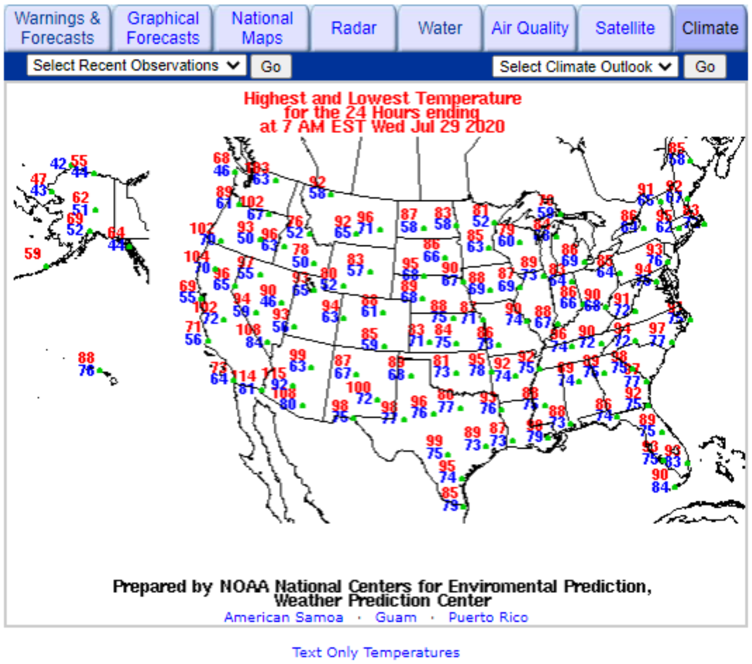


HOME >Land Surface Monitoring and Prediction
Soil Wetness Climatology (mm)
Move cursor over product parameter name to display the graphic.
Soil Wetness Climatology (mm)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Calculated Soil Wetness Climatology x 100
(1971–2000) AUG
50N
45N
40N
35N
30N
25N
120W
100W
80W
20 30 40 50 60 70 80 90

APPENDIX C
Procedure to Locate Local Average Precipitation Data
SOP: ERT-PROC-2084-21
March 2021

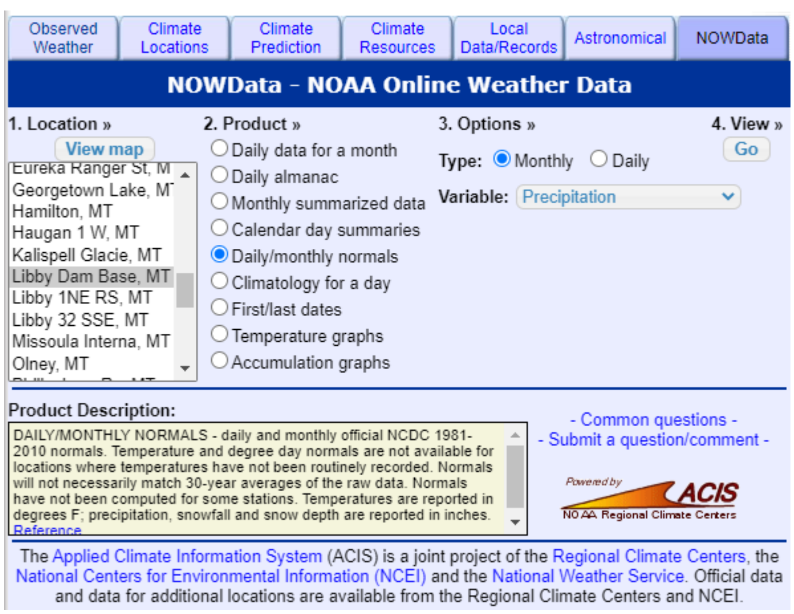
Locating Climatological Precipitation Norms by National Weather Service Observation Station

1. Go to www.weather.gov.
2. Click the **Past Weather** tab. A map similar to below will appear. Click on the area of interest on the map.

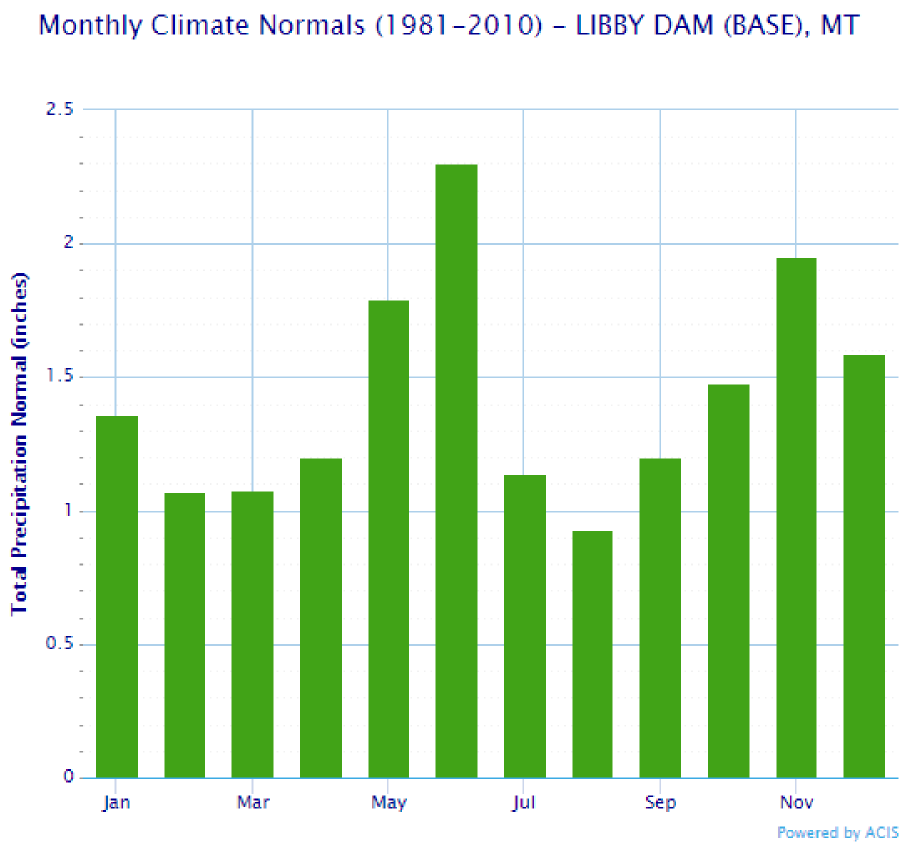


Click on the NOWData tab.

1. Location: Choose site closest to area of interest.
2. Product: Select **Daily/Monthly Normals.**
3. Type: **Monthly.** Variable: **Precipitation**
4. Click **Go**.



A graphic similar to below should appear.



Month	Total Precipitation Normal (inches)
January	1.36
February	1.07
March	1.08
April	1.20
May	1.79
June	2.30
July	1.14
August	0.93
September	1.20
October	1.48
November	1.95
December	1.59
Annual	17.09